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THE VERIFICATION OF LANDSAT DATA IN THE GEOGRAPHICAL ANALYSIS OF WETLANDS IN WESTERN TENNESSEE

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Research Report

for the period

July 21, 1975 - April 21, 1976

The NASA/University of Tennessee Geography wetlands contract is progressing with two-thirds of the mapping phase of the project completed. Since the last reporting period (March-June 1975), we have concentrated our efforts towards three main areas of research: 1) the generation of wetland maps based on Landsat imagery, 2) the generation of wetland maps from medium altitude aircraft imagery, and 3) continued field investigations in the west Tennessee wetlands.

1.0 WETLAND MAPPING FROM LANDSAT IMAGERY (Bands 4, 5, 6, 7)

Fifteen maps of the West Tennessee wetlands area have been produced by visual interpretation from Landsat I imagery (Maps 1-15). Landsat I bands 4, 5, 6, 7 and color composite imagery were mapped using an 8X magnifier and a light table for each of three selected dates: September 13, 1972; February 22, 1973; and May 5, 1973. The time taken to produce each map has also been recorded for analysis on a cost/time/benefit basis. Maps 1-12 (placed at the end of the report) illustrate the changes that occur in the wetlands from band to band for the same black and white images (bands 4, 5, 6, 7) and from one seasonal period to another. An evaluation of the corresponding color composite imagery is presented later in this report.

Significant changes occur in the size of the wetlands because of seasonal fluctuations in vegetational characteristics and precipitation. A greater amount of wetlands area is either saturated or inundated on the May 5 high water imagery in contrast to the swamplands present in the September low water imagery (Maps 1-4). The February 22 imagery (Maps 5-8) represents a median wetland stage.

Although temporal fluctuations affecting the size of the West Tennessee wetlands are apparent on the three dates and bands of LANDSAT imagery, the dynamic characteristic of the wetlands cannot be attributed exclusively to seasonal factors. A closer inspection of Maps 1-15 reveals that significant changes in wetland morphology occur within the different bands for the same image date. These intra-image fluctuations are created by the spectral differences exhibited by each of the four black and white bands used in the LANDSAT mapping procedure. The variations that exist between the four maps generated for the same image date are dependent upon a number of human and technical interpretational parameters.

Since maps 1-12 have been produced by visual definition alone, problems related to this method of interpretation have contributed to the changes evident in the wetlands from band to band within the same image date. A built-in aberration exists because of the small scale of the imagery and the size of the pen used to draft the maps. It is inevitable at an image scale of approximately 1:1,000,000 that the width of the pen point obliterates some of the imagery detail. A #000 Rapidograph pen was used to trace the maps and it is conceivable that a deviation in the actual versus mapped area of the wetlands has

been created by the size of the ink line. This distortion, however, is considered to be relative for all twelve maps and in the final comparative analysis, only the actual image will be used to measure accuracy and not the maps.

Several other mechanical and visual related interpretational problems must be considered in a discussion of the intra-image and inter-image changes that are evident of wetlands.

Maps 1-12. The altitude of LANDSAT as it passes over the wetlands shifts to the west and slightly north of the September 13 image in the February and May images. Consequently, some of the upper reaches of the Obion, Forked Deer, and Hatchie wetlands are eliminated from the May 5 imagery (Maps 1-12). The February 22 imagery (Maps 5-8) on the other hand is only slightly affected by the westward movement of the satellite. The upper reaches of the Loosahatchie River located to the south of the Hatchie River in the September 13 (Maps 1-4) and February 22 (Maps 5-8) map series disappears almost entirely on the May 5 data (Maps 9-12). The aberrations created by the movement of LANDSAT from date to date, however, are not severe enough to weaken the wetland maps as a data base.

One of the most confusing problems encountered while visually mapping the West Tennessee wetlands from LANDSAT imagery concerns the conflict of tonal signatures within the swamps and with their surroundings. In bands 4, 5, 6, and 7 of the imagery, subtleties in gray tones must be differentiated in order to distinguish wetlands from non-wetlands. The swamplands generally appear as a darker tone than their surroundings in the black and white visible (bands 4, 5) and infrared (bands 6, 7)

imagery. The degrees of darkness in wetland gray tones compared to non-wetland areas varies to some extent, however, in different parts of the swamplands. The signature for wetlands is darker than their surroundings because of the greater density of vegetation and the saturated or inundated ground conditions present in the wetlands. These features in turn create a darker, almost black, gray signature that is distinguishable on the imagery.

The delimitation of wetlands from the imagery, therefore, is based on the identification of gray tonal signatures that are a distinctive characteristic of swamplands. Occasionally, the familiar gray wetland tones become mixed with other black and white signatures and thereby make the delimitation of swamplands difficult. Conflicts in tonal signatures also occur from time to time within the wetlands themselves which complicates the mapping process.

The delimitation of wetlands from non-wetland signatures is particularly confusing at the wetland/cropland fringe. Here cleared and cultivated land signatures intermix with wetland tones and there is no clear-cut boundary visible between the two areas. In general, however, the problem of delimiting wetlands at the cropland interface depends on which band is used for interpretation and at what time of year the imagery was taken.

1.1 Comparative Analysis of Landsat Imagery by Spectral Band

Of the black and white visible and infrared bands, band 4 (Maps 1, 5, and 9) is the most difficult for detecting the wetland/cropland fringe and for mapping wetlands overall. Band 4 produces a

"fuzzy" wetland signature because of its poor ability to detect water and water related characteristics. Consequently, Band 4 is not conducive for mapping wetlands.

Band 5 (Maps 2, 6, and 10) on the other hand produces a clearer swampland signature and the wetland/cropland interface is easier to map. Band 5 is also useful for identifying shallow, flooded areas in and around the wetlands.

Bands 6 (Maps 3, 7, 11) and 7 (Maps 4, 8, 12), however, are the lands best suited for mapping wetlands from LANDSAT imagery. Wetlands are easier to delimit on Band 7 than on Band 6. Band 7 is clearer and sharper than Band 6 and exhibits greater contrast between wetland signatures, because the imagery is sensed at a point farther into the near infrared portion of the spectrum. Flooded wetlands, therefore, are more evident on Band 7 than in Band 6 along with better tonal recognition at the wetlands/cropland fringe. Band 6, however, is better suited to mapping wetlands in and around cultural features, such as urban areas and highway crossings because it possesses some characteristics from the visible light spectrum in addition to its near infrared qualities.

1.2 Comparative Analysis of Landsat Imagery by Climatic Season

The seasonal aspect of the imagery is another parameter that must be taken into consideration when mapping the wetland/cropland intereface. Contrast and tonal signature qualities of the wetlands vary with the seasons in response to changing soil moisture, agricultural, and vegetational conditions.

1.21 Fall Season - September 13, 1972

In the September 13 imagery the contrast between wetlands and non-wetlands is reduced because of the dry soil conditions, heavy vegetational coverage in agricultural crops and pasturelands, and forest foilage. These physical conditions affect the delimitation of wetland signatures because there is less water in the wetlands to contrast with the dryer non-wetlands. Furthermore, the dense agricultural cropland cover reflects a signal that occasionally blends with the wetland signatures at the swampland/cropland fringe. A large amount of forest cover in the uplands also produces a signature similar to that of a genuine wetland. The seasonal problems involved in mapping wetlands from the September 13 imagery become especially acute in three specific areas: (1) at the upper reaches of the Obion, Forked Deer, and Hatchie Rivers, (2) in the eastern portion of the wetlands area along the tributary streams which branch out from the wetlands into non-wetland agricultural areas; and (3) in the loess uplands near the Mississippi River.

At the upper reaches of the wetlands the topography is rolling and heavily dissected and much of the land is covered with forest vegetation. The wetlands in this area become smaller in size and begin to branch out as they reach the headwaters of the rivers. Consequently, there is less wetland area to be detected. Furthermore, the wetland signatures intermix with the upland forest signatures and become difficult to map.

The tributary wetlands of the Obion, Forked Deer, and Hatchie River in West Tennessee are also a source of mapping problems. These croplands and, therefore, are difficult to delimit. The Rutherford Fork of the Obion River is a good example of a major wetland tributary that is almost undetectable on the September 13 LANDSAT imagery. The wetlands along Rutherfor Fork are small and become confused with the surrounding agricultural signatures.

Another problem in mapping the wetlands from the September 13 imagery occurs as the swamplands meet the upland loess areas near the Mississippi River. The loess Bluffs reflect a signature similar to the wetlands and it is difficult in some places to separate wetlands from uplands. Such areas include wetlands along the lower Obion River which parallel the loess bluffs north of Dyersburg, Tennessee. Also, the swamplands around Reelfoot Lake abutt the loess uplands to the west and are particularly difficult to map. Several large lowland wetland areas in the Mississippi alluvial valley are also troublesome to visually separate from the loess uplands. In the September 13th Band 6 black and white infrared imagery (Map 3), however, the wetlands appear darker that the loess bluffs. Consequently, because of the better contrast, a clearer line of demarcation can be drawn between the uplands and lowlands as opposed to on bands 4, 5, and 7.

The February 22, 1973 imagery (Maps 5-8) of the West Tennessee wetlands area presents some different seasonally related problems compared to those encountered in mapping the September 13 imagery. There is little problem in delimiting the wetlands at the upper reaches or along the tributaries because of the high contrast between

the wetlands and non-wetlands on the imagery. At the time the imagery was taken, winter rains had fallen over the West Tennessee study area and as a result, the wetlands in the region appear"wetter" than in the September 13 dry season imagery. Also, agricultural fields are uncultivated and deciduous vegetation is dormant in the February 22 imagery, creating a high contrast situation between the rain-swollen wetlands and non-wetlands that surround the swamps. Consequently, the wetlands are generally easy to map because they appear darker than the surrounding signatures.

A real problem arises, however, in trying to distinguish between genuine wetlands and non-wetlands in the lowland Mississippi alluvial valley areas along the lower Obion and Forked Deer Rivers. Here the wetted and saturated lowland signatures mimic those of a "true" swampland, and except for areas that are flooded with standing water present, it is difficult to separate wetlands from non-wetlands. The problem is mitigated, however, by the definition of wetlands used in the mapping process. This defination entitles areas that appear "wet" on the imagery to be classified as a swampland; areas that are wet at the time the imagery is taken may be temporal or ephemeral wetlands but they still can be classified as "wetlands" for mapping purposes. Therefore, areas in the Mississippi alluvial valley that reflect a wetland signature have been mapped as swamplands, regardless of whether or not they are permanent wetlands like those existing along the upper Obion, Forked Deer, and Hatchie Rivers.

1.23 Spring Season - May 5, 1973

The May 5, 1973 imagery (Map 9-12) has another set of seasonal and weather related factors that affect the mapping procedure. At the time the imagery was sensed, severe flooding conditions plagued the West Tennessee study area. The rain swollen Mississippi River inundated much of the alluvial valley, backing up the tributary rivers in the area which resulted in flooding along the Obion, Forked Deer, and Hatchie Rivers.

Because of the high water conditions and the saturated or wetted soil circumstances in the region created by the heavy rain that had doused the area, permanent wetlands are difficult to delimit. The flooded wetlands in the May 5 black and white images produce two signatures that are keys to swampland identification: a dark gray, almost black tone indicating deeply flooded areas with little green vegetation visible, and a much lighter gray tone denoting areas where flooding is shallow and where dense, green swampland vegetation is present. The darker signatures represent areas that are either so heavily flooded that the vegetation is entirely submerged, or areas of limited forest and bushy vegetational growth. As a result, these dark gray tonal reflections are easy to delimit because of the high contrast with the lighter surrounding agricultural lands. The lighter swampland signatures, however, are diffcult in places to separate from the bordering non-wetland signatures. The swamps contain deciduous and bushy vegetation which produces a tonal signal similar to that of the peripheral, saturated agricultural

and forest lands. Consequently, the wetland signatures blend with the forest and cropland signatures making mapping of the swamplands from the imagery an arduous task.

Tributaries of the Obion, Forked Deer, and Hatchie Rivers are also difficult to map, because of the weather and seasonally related conditions that existed in the West Tennessee study area at the time the imagery was taken. The tributary wetlands, enlarged by the heavy precipitation and flooded main rivers, produce tonal signals similar to the surrounding non-wetland signatures and in many cases, become absorbed into the background reflections. The degree of mapping difficulty varies from image to image, and no single band is best suited for delimiting tributary swamplands.

Wetlands at the upper reaches of the Obion, Forked Deer, and Hatchie Rivers have been troublesome to define and hamper the mapping procedure. The swamplands become narrower at the upper reaches and the dark signatures produced by heavy flooding are absent. Consequently, the vegetational signature of the wetlands blends with the tonal signal produced by the dissected, undulating, foliated uplands, and the two signatures become almost inseparable.

A cartographic dilemma concerning the mapping of wetlands in the Mississippi alluvial valley similar to that encountered in the February 22 imagery, also occurs in the May 5 LANDSAT imagery series. As a result of the widespread flooding and saturated soil conditions present at the time the imagery was sensed, large portions of the lowlands bordering the Mississippi River appear as wetlands. Actually, these lowland areas

mapped as wetlands are not permanent swamplands, but are saturated agricultural fields that have been transformed into temporary wetlands.

The problems described thus far in mapping the wetlands of West Tennessee from the May 5 black and white imagery, are compounded by the presence of clouds scattered over the area. The cloud cover is light and generally does not hinder the mapping process except when delimiting wetlands in the following areas: sections of the lower Hatchie River; the North Fork of the Obion River just north of the confluence with the Obion, and along most of the Rutherford Fork of the Obion River.

Aside from the specific problems cited above for each of the three dates used in delimiting the West Tennessee wetlands, the overall darkness of the imagery further contributes to the difficulties encountered in the mapping procedure. Bands 4 and 5 are particularly dark and consequestly the contrast between the wetland and upland tonal signatures is subdued making the delimitation of swamplands laborious. The darkness of the imagery, however, is offset by the increased contrast qualities in bands 6 and 7 which are attributable to the excellent water distinguishing abilities of the infrared bands.

Another interpretational problem common to all the LANDSAT imagery used in mapping the West Tennessee swamplands is the difficulty of discerning wetlands around urban areas. Wetlands which come into contact with built-up areas become narrower and are broken up by urban encroachment. The wetland tonal signatures, therefore, are more difficult to define and become lost in the urban tonal signature. This is particularly true around Dyersburg, Tennessee where the Obion River

wetlands have been altered by urban encroachment and directly ajoin built-up land. Here the wetland tonal signature fuses with the urban signature. The South Fork of the Forked Deer River wetlands at Jackson, Tennessee, however, are easier to delimit because the swamps are wider and have more vegetative cover than the wetlands at Dyersburg.
Although there is a problem of distinguishing wetlands from urban areas on the imagery, it is less apparent on bands 6 and 7. Urban signatures on these bands are subdued while water characteristics are enhanced making delimitation easier than on bands 4 and 5.

2.0 ANALYSIS OF LANDSAT COLOR COMPOSITE IMAGERY

The discussion thus far has pertained to problems encountered in mapping the wetlands of West Tennessee from black and white LANDSAT imagery. These interpretational problems are greatly reduced, however, when mapping from the color composite imagery for the three dates used in the study. Since it is difficult for the human eye to discriminate between more than 20 shades of gray, many tonal subtleties important to the differentiation of wetlands from non-wetlands, particularly on the wetland/cropland fringe, may become confused or mixed with the more dominant black and white signatures. Therefore, many aberrations which exist on the West Tennessee wetland maps generated from black and white LANDSAT imagery, can be traced to the problem of separating the nuances in gray scale gradients between one shade of gray and another.

The dilemma of differentiating between gradients of scale, however, is mitigated considerably when visually mapping from color composite LANDSAT imagery. It is much easier to discriminate between subtleties in color values than it is between gray scale values and

consequently, color composite imagery is a boon when mapping the West Tennessee wetlands from LANDSAT imagery. Wetlands can be identified on the September, February, and May color composite imagery by their characteristic deep red signature created by the reflectance of the dense swampland vegetation and also by the presence of standing water (Maps 13-15). The amount of water in evidence within the wetlands varies seasonally with the most widespread wetland inundation appearing in the February and May images.

Color enhanced LANDSAT imagery permits a greater ability to visually detect subtleties in wetland tonal signatures, particularly at the wetland/cropland interface where signatures tended to blend together on the black and white imagery. The darker wetland signature contrasts well with the lighter colored surroundings making the delimitation of wetlands an easy task. At the extreme eastern portion of the study area, however, where the narrow upper reaches of the wetlands intersect the heavily forested and dissected uplands, it is difficult in some areas (especially on the September 13 color image) to separate wetlands from non-wetlands. The foliated uplands reflect a signature similar to that of the wetlands and consequently, it is difficult to visually delimit swamplands.

Another problem encountered while mapping wetlands from the color composite imagery occurs in the February 22 imagery (Map 14). Wetlands existing in the Mississippi alluvial valley are difficult to separate from saturated lowlands as they were in the black and white LANDSAT imagery. The lowland and wetland signatures are similar in appearance because of

the increased soil moisture conditions that were prevalent in the area at the time the imagery was sensed. Consequently, aberrations in wetland delimitation may occur in the lowlands along the Mississippi alluvial valley on the Februarv 22 color composite image map (Map 14). It was noted earlier, however, that this problem is abated by the definition of wetlands used throughout the mapping procedure. Additionally, errors may also occur on the May 5 color image wetlands map (Map 15) because of the presence of scattered clouds over the study area particularly around the middle portion of the Hatchie River.

Although minor interpretational problems do occur in mapping the West Tennessee wetlands from color composite LANDSAT imagery, it is much easier to differentiate between nuances in wetland versus non-wetland tonal signatures on color enhances imagery in comparison with black and white imagery. The aberrations created by this problem are reduced, however, when mapping from the black and white infrared bands (bands 6 and 7).

Despite the improved resolution (i.e. ability to descriminate between tonal signatures) of color enhanced imagery over black and white LANDSAT imagery, there is a significant deficiency inherent to the LANDSAT data collection system which omits a very important element necessary for the accurate delimitation of wetlands in West Tennessee: LANDSAT imagery is not stereoscopically compatable and, therefore, topographic variations can not readily be detected. The ramifications created by the inability to distinguish topographic variations within the Obion, Forked Deer, and Hatchie River basins from LANDSAT data will be discussed later in this report.

3.0 WETLAND MAPPING FROM MEDIUM ALTITUDE AIRCRAFT IMAGERY

The second phase of our research during the reporting period has centered on the location and mapping of 15 transect areas in the West Tennessee wetlands selected from medium altitude(1:24,000) color infrared aircraft imagery provided by the NASA Marshall Space Flight Center. The amount of time taken to generate each transect map has also been recorded in order to analyze the time/benefit characteristics of maps produced from the medium altitude imagery in comparison with the LANDSAT wetland maps. These transects exist as data control areas and will function as calibration parameters when evaluating the success of LANDSAT imagery as a tool for mapping wetlands during the accuracy testing procedure. The transects, therefore, for the purposes of LANDSAT data verification in this study represent actual ground truth information at 15 selected points in the West Tennessee wetlands area, although in reality the aerial photography acts only as a medium for observing ground level conditions.

Each transect map represents the wetland data obtained from 15 individual photographs selected for study because they displayed some dominant photomorphic feature or features that are detectable on the 3 dates of LANDSAT imagery used to produce Maps 1-15. Examples of features that were used to select transect sites are as follows: the confluence of rivers or streams, urban areas, lakes, major highways such as Interstates, prevalent topographic phenomena, and significant patterns of wetland encroachment. These photomorphic physical and cultural elements can, therefore, be used as ground alignment points for calibration purposes during the accuracy testing procedure. Furthermore, the transect sites

are located in areas that charcterize the wetlands study area at various points within the Obion, Forked Deer, and Hatchie River basins in order to present an overall perspective of the West Tennessee swampland milieu. (e.g. upper reaches, middle and lower sections.)

The location, photographic frame number, and description of the significant photojorphic elements for each transect site is outlines below (Map 16 - Figures 1-15 are located at the end of this report):

Figure 1 - (Roll 31-2, Frame #602, April 23, 1974) - Confluence of the North and South Forks of the Obion River in eastern Obion County. Significant features: Confluence fo the two forks of the Obion and the large marshy area near the confluence point.

Figure 2 - (Roll 31-2, Frame #375, April 23, 1974) - Middle Fork of the Forked Deer River at the confluence with Buck Creek on the Gibson-Crockett County line. Significant features: Confluence of Buck Creek with the Middle Fork.

Figure 3 - (Roll 31-2, Frame #475, April 23, 1974) - South Fork of the Obion River at the confluence with Crooked Creek in northwestern Carroll County. Significant fearures: Confluence of the Obion River with Crooked Creek and Clear Creeks at the upper reaches of the Obion.

Figure 4 - (Roll 31-2, Frame #413, April 23, 1974) - Confluence of the North and Middle Forks of the Forked Deer River near the Dyer-Gibson-Crockett County lines. Significant features: Confluence area of the two forks of the Forked Deer and the large area of standing water and dead timber on the Middle Fork of the Forked Deer near the confluence point.

(Figure 4 is not completed because the pattern symbolization used in Figures 1-4 display poor contrast value when photographed. Subsequently, the symbolization patterns are different in Figures 5-15; Figures 1-4 will be changed to conform with the symbolization patterns of the succeeding figures.)

Figure 5 - (Roll 31-2, Frame #614, April 23, 1974) - Section of Obion River southwest of Obion, Tennessee, near the Obion-Dyer County line. Significant features: Large wedge-shaped encroached area on the south side of the Obion River.

Figure 6 - (Roll 31-2, Frame #391, April 23, 1974) - North Fork of the Forked Deer River at Dyersburg, Tennessee. Significant features: Contact zone of large urban area with the Obion River wetlands. Also, the confluence of Pond Creek with the North Fork of the Obion.

Figure 7 - (Roll 31-2, Frame #594, April 23, 1974) - Confluence of the Middle and South Forks of the Obion River near the Obion-Gibson-Weakley County lines. Significant features: Confluence of the two forks of the Obion and large cleared area carved out of the wetlands at the confluence point.

Figure 8 - (Roll 31-3, Frame #640, April 24, 1974) - Reelfoot lake at Samburg, Tennessee in extreme western Obion County. Significant features: Reelfoot Lake with interior wetlands, and contact zone of Mississippi alluvial lowlands with Reelfoot Lake and loess uplands.

Figure 9 - (Roll 31-2, Frame #624, April 23, 1974) - Obion River at confluence with Running Reelfoot Bayou in northwestern Dyer County.

Significant features: Confluence of Running Reelfoot Bayou with the Obion and contact zone of loess uplands, the Mississippi alluvial lowlands and the Obion River.

Figure 10 - (Roll 31-1, Frame #188, April 23, 1974) - Hatchie River at the crossing of U.S. Route 79 southwest of Brownsville, Tennessee, in Haywood County. Significant features: Hatchie River wetlands near the middle portion of the river and the presence of large cleared area on the south side of the Hatchie.

Figure 11 - (Roll 31-1, Frame #134, April 23, 1974) - Hatchie River at the confluence with the Big Bottom Drainage Canal southeast of Bolivar, Tennessee in Hardeman County. Significant features: Confluence of the Big Bottom Drainage canal with the Hatchie, Hatchie wetlands at the upper reaches of the river, and the distinct pattern of wetland encroachment on the south side of the Hatchie.

Figure 12 - (Roll 31-3, Frame #694, April 23, 1974) - Confluence of the Hatchie River with the Mississippi River. Significant features: confluence of the Hatchie River with the Mississippi, Confluence of Indian Creek with the Hatchie, marshy area to the mouth of the Hatchie, and the contact zone of the loess uplands with the Mississippi alluvial lowlands, the Mississippi River and the Hatchie River bottomlands.

Figure 13 - (Roll 31-1, Frame #180, April 23, 1974) - Crossing of the Hatchie River by Interstate 40 and State Route 76 south of Brownsville, Tennessee in Haywood County. Significant features: I-40 and SR 76 crossing through the Hatchie wetlands and the presence of several water-filled borrow pits on the west side of I-40 within the swamplands.

Figure 14 - (Roll 31-1, Frame #265, April 23, 1974) - Confluence of Nixon Creek with the South Fork of the Forked Deer River at the Crockett-Haywood County lines northeast of Ripley, Tennessee. Significant features: Confluence of Nixon Creek with the South Fork of the Forked Deer and the presence of Black Creek to the north of the confluence area.

Figure 15, (Roll 31-2, Frame #441, April 23, 1974) - Section of the Rutherford Fork of the Obion River east of Dyer, Tennessee, in Gibson County. Significant features: Block of wetlands surrounded by cleared land along the Rutherford Fork of the Obion.

In mapping Figures 1-15 from the roll imagery, we found that the percentage of overlap needed to make the photo frames stereoscopically compatible created a significant amount of parallax "warping" at the edges of the photographs. Consequently, aberrations will occur when attempting to caliberate the individual frames of the roll film selected as transect sites with the same areas on the LANDSAT imagery during the accuracy testing procedure.

4.0 CONTINUED FIELD WORK IN THE WEST TENNESSEE WETLANDS AREA

During the last reporting period, two field trips were conducted in the West Tennessee wetlands study area; one on October 19-24, 1975, and the other on December 14-17, 1975, The objectives of the October field trip were four-fold: (1) to study the transect sites that had been selected and partially mapped up to that point in time, (2) to inspect the vegetation cover of the wetland environs from the ground during a period of full foliation, (3) to record ground lev el data for several proposed transect sites that had been located but not mapped from the

medium altitude imagery, and (4) to inspect portions of the wetlands that were inaccessible because of flooding during the first field trip to the study area in March 1975.

Ground truth observations were necessary to supplement the reliability of the individual frames of the medium altitude aircraft imagery used in producing the transect maps. In many cases, it was difficult to delimit wetlands or wetland related phenomena (e.g. marshes, dead timber, saturated soil conditions) from the visual interpretation of the individual aerial photographs even with the assistance of topographic maps. Accordingly, ground truth observations were required to help delineate wetland from non-wetland forest cover on the aerial photography. Swampland or bottomland vegetation is similar in appearance to upland vegetation within the study area, and there is no real detectable change in many cases between wetland and upland foliage. In fact, field observations indicate that topography is more of a determinational factor than is vegetational differentation. The true "wetlands" of the Obion, Forked Deer, and Hatchie River basins conform to the bottomlands of the rivers and generally exist below the 300 foot contour level as topographic maps and field data indicate. Consequently, many portions or the Obion, Forked Deer, and Hatchie River basins have a gentle bank-to-bank gradent and the slope from the uplands to the bottomlands is almost unnoticeable.

Because the delimitation of wetlands is based more on topographic than vegetative characteristics, topographic maps or imagery capable of

sensing physiographic variations are mandatory when mapping the West Tennessee swamplands. The lack of stereoscopic compatability between LANDSAT imagery mentioned earlier in the report, therefore, is one of the greatest pitfalls of using LANDSAT data to map wetlands.

In addition to supplying back-up data for the transect sites that had been mapped at the time the October field trip was conducted, ground level observations were needed to assess the photomorphic characteristics of several proposed but unmapped transect site locations. Also, the October field excursion permitted travel into some areas, particularly along the Mississippi alluvial lowlands, that were inundated when the March 1975 field work was conducted.

The second field work in December was needed to clarify several points of confusion that arose while mapping the remaining transect sites selected from the medium altitude aircraft imagery. A paramount objective of the field trip was to inspect the topographic and vegetative characteristics which comprise the wetland/cropland fringe within the transect areas. This contact zone between wetlands and non-wetlands is troublesome to delimit in many of the transects. Field data indicates that much of the confusion is created by the presence of non-forested wetlands on the wetland/cropland fringe. The non-forested wetlands appear similar to cleared swampland or agricultural areas and, therefore, make mapping of the swampland/non-swampland zone difficult. Furthermore, it was the objective of the December field trip to observe the West Tennessee wetlands during the winter pre-flood stage and thereby provide inter-seasonal ground truth data for comparison with the September dry season and February wet season LANDSAT imagery.

5.0 CONTINUED INVESTIGATIONS

With the completion of the LANDSAT wetland map series and the delineation of transect areas for use as ground control sites, the verification or accuracy testing of LANDSAT data in the geographic analysis of swamplands in West Tennessee is ready to begin. Three principal techniques, a grid system, radii measurement procedure, and magnifying comparator or polar planimeter (all subject to refinement or change as research continues) will be used at the onset of the LANDSAT data accuracy analysis. Each of the techniques will be used on a trial transect area with the most efficient and accurate method (i.e. the one which produces the least percentage of error) used to test the remaining transect sites against the same areas on LANDSAT imagery.

The gird system technique will essentially consist of setting scaled grids over the designated transect areas on both the LANDSAT and medium altitude aircraft imagery. The amount of wetland area contained within the grids will be correlated according to the scale of the imagery, and an accuracy figure will be computed based on the spatial calibration of wetlands acreage present on the aircraft imagery versus the same area on the LANDSAT imagery. In the radii measurement method, scaled radii will be constructed from selected points common to both the medium altitude aircraft and LANDSAT imagery (i.e. points that are easy to distinguish on the two types of imagery such as the confluence of rivers or streams.) The amount of wetlands area contained within the corresponding aircraft and LANDSAT imagery transect sites will be computed and thereby give a standard for measuring the percentage of error between the two types of imagery. The third accuracy testing technique

will use either a magnifying comparator or polar planimeter to calculate the amount of wetlands area that exists within each transect on the medium altitude photography for a comparative areal evaluation with the same transect site on the LANDSAT imagery.

After the LANDSAT imagery used in the study has been tested for accuracy via the results obtained from an analysis of the above techniques, an evaluation will be made to assess the utility of LANDSAT data as a geographic tool for delimiting, monitoring, and measuring wetlands in West Tennessee. (Field work will also be conducted when necessary to provide ground truth data during the LANDSAT evaluation procedure.) Furthermore, the multiband LANDSAT wetland maps (Maps 1-15) will be assessed for cartographic reliability, based on the parameters of total mapping time, ease of interpretation, and overall content.

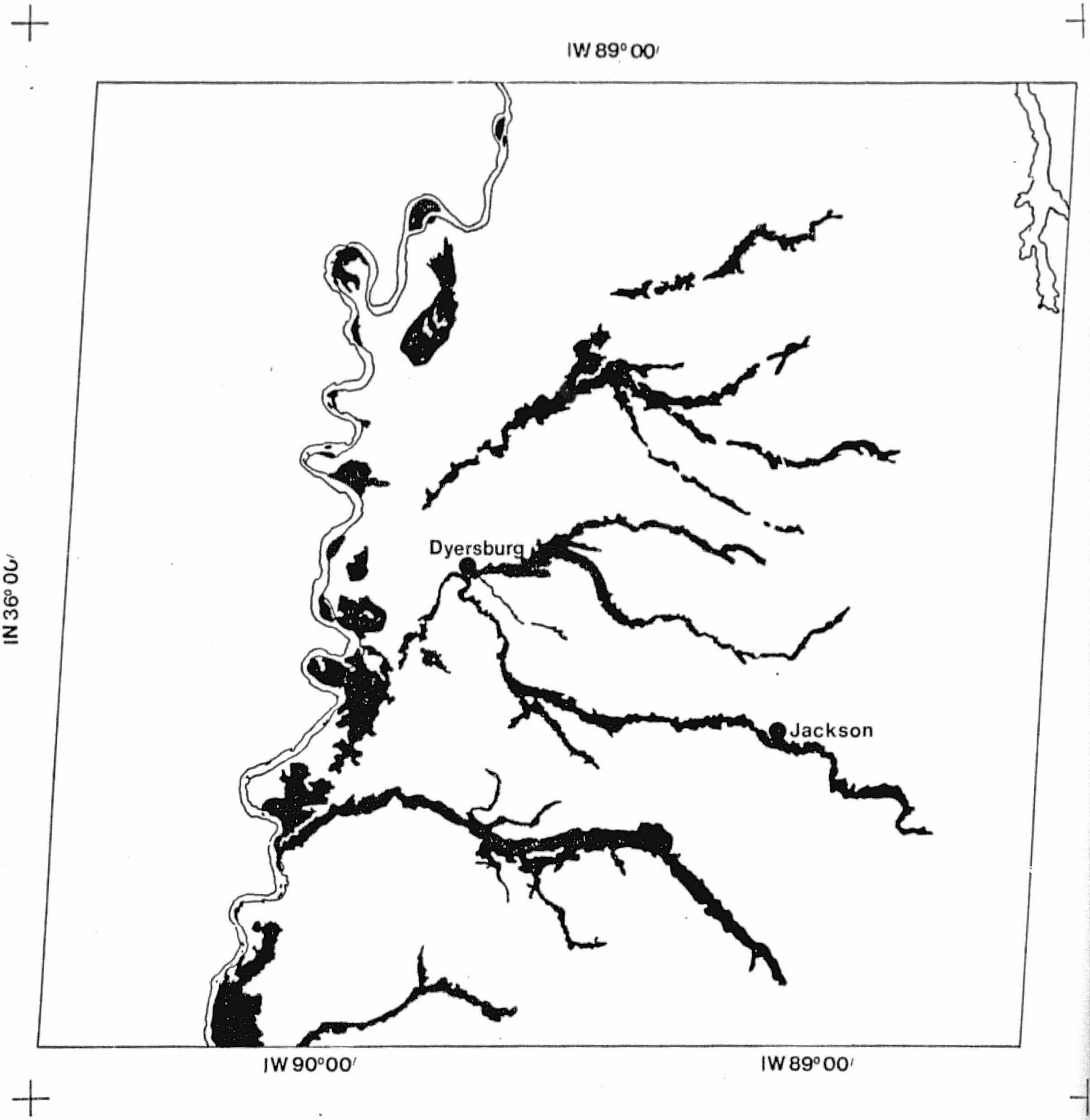
In addition to the research objectives already mentioned, several other goals for continuing investigations are stated in the proposal submitted to Marshall Space Flight Center concerning the extension of NASA Contract NAS8-31143. Under the stipulations of the new contract extension granted in December 1975, a more technical analysis of the West Tennessee wetlands LANDSAT and medium altitude aircraft imagery will be conducted emphasizing the results obtained from mechanical tests of the imagery.

LEGEND FOR MAPS 1-15

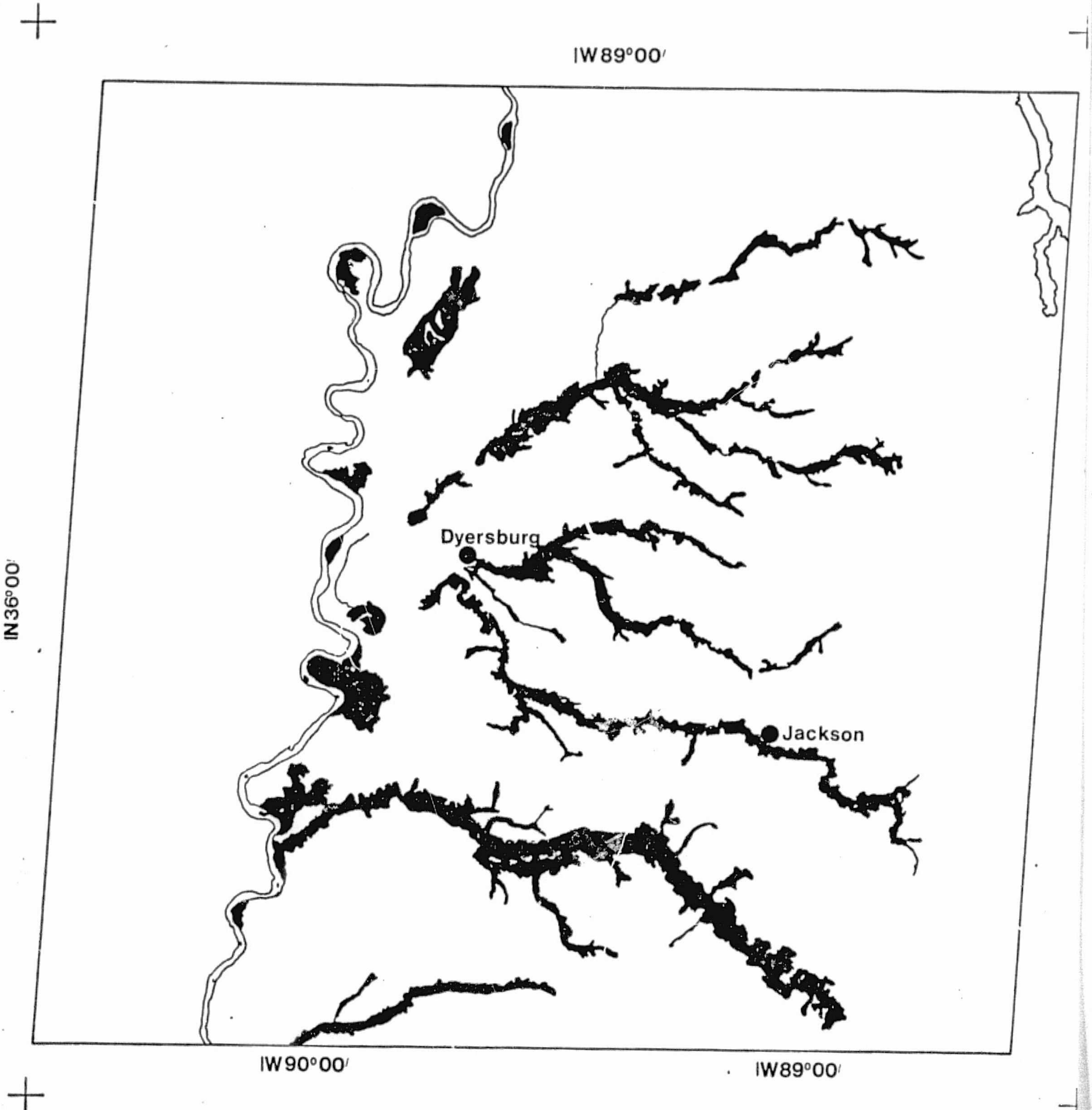
Wetlands

Flooded Lands

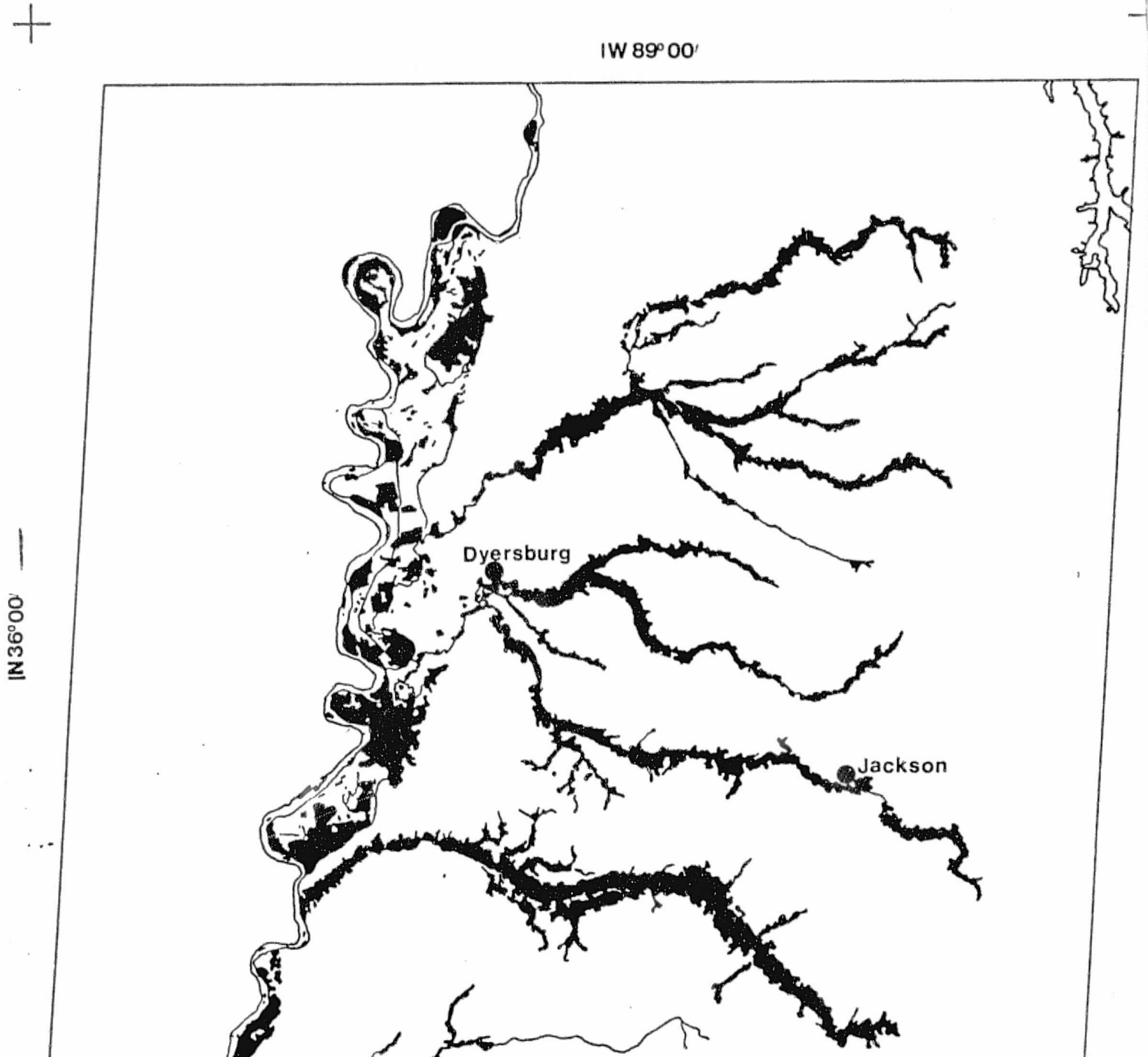
Urban Areas



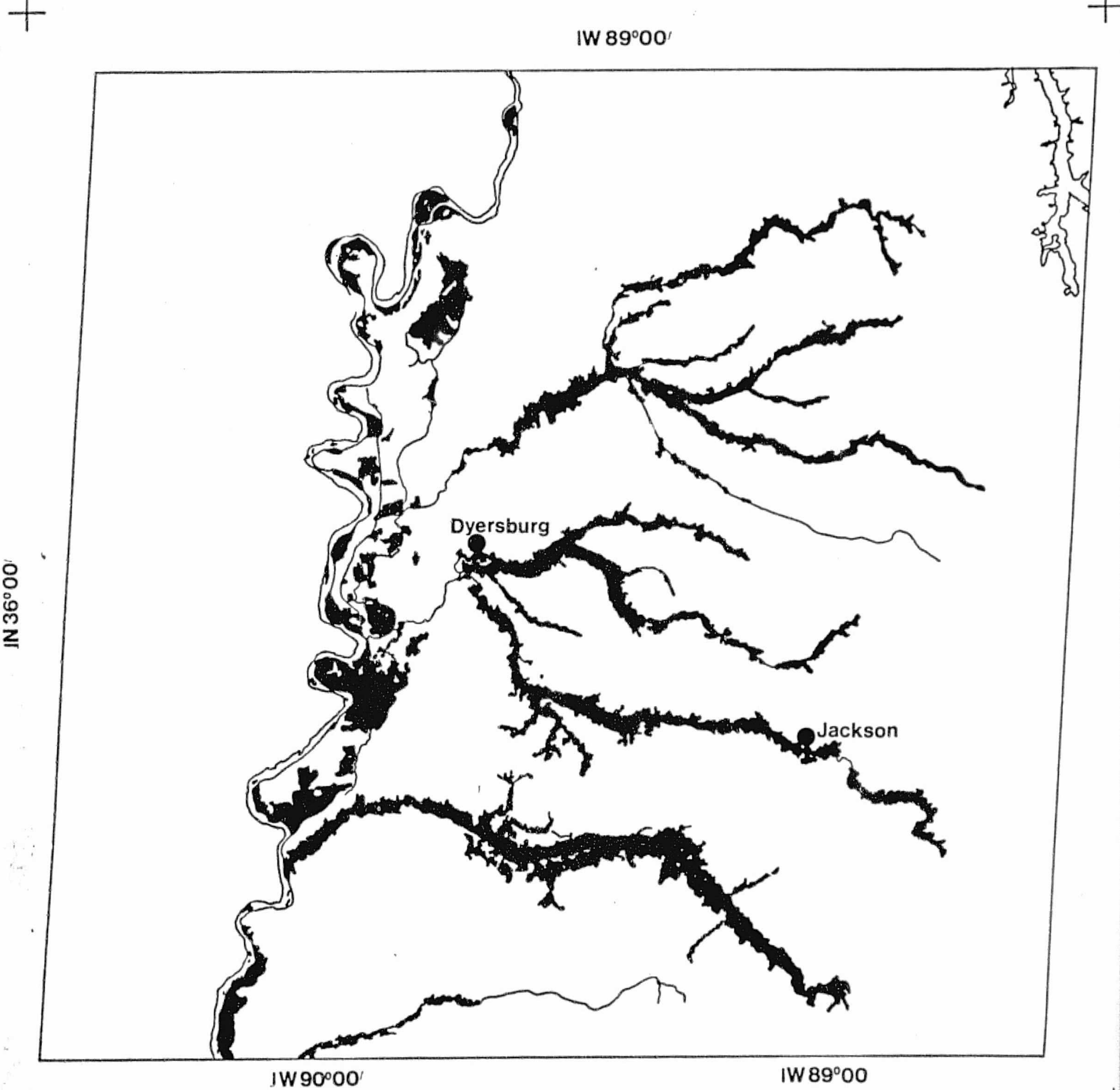
MAP 1. September 13, 1972 - Band 4.



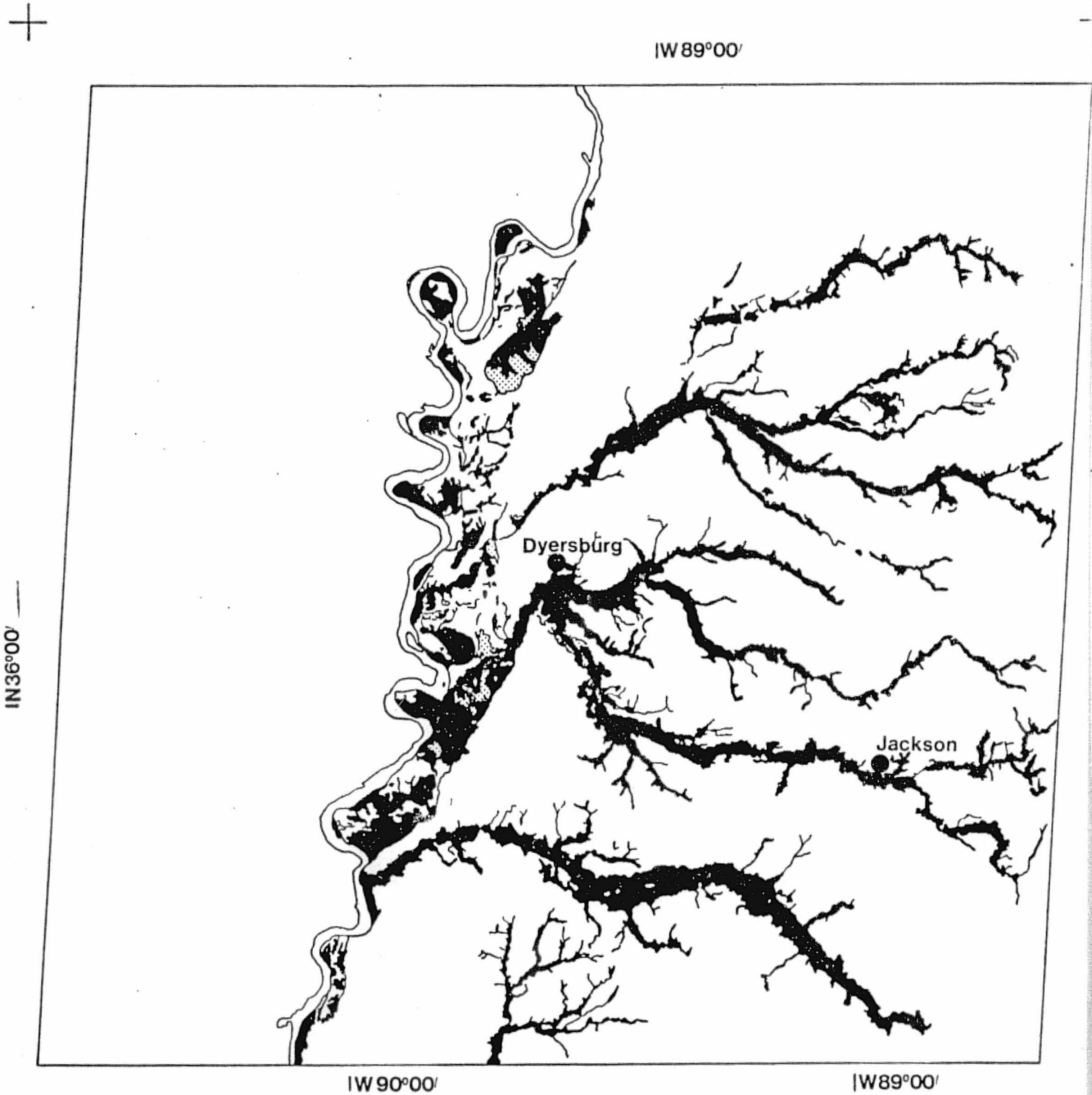
MAP 2. September 13, 1972 - Band 5.



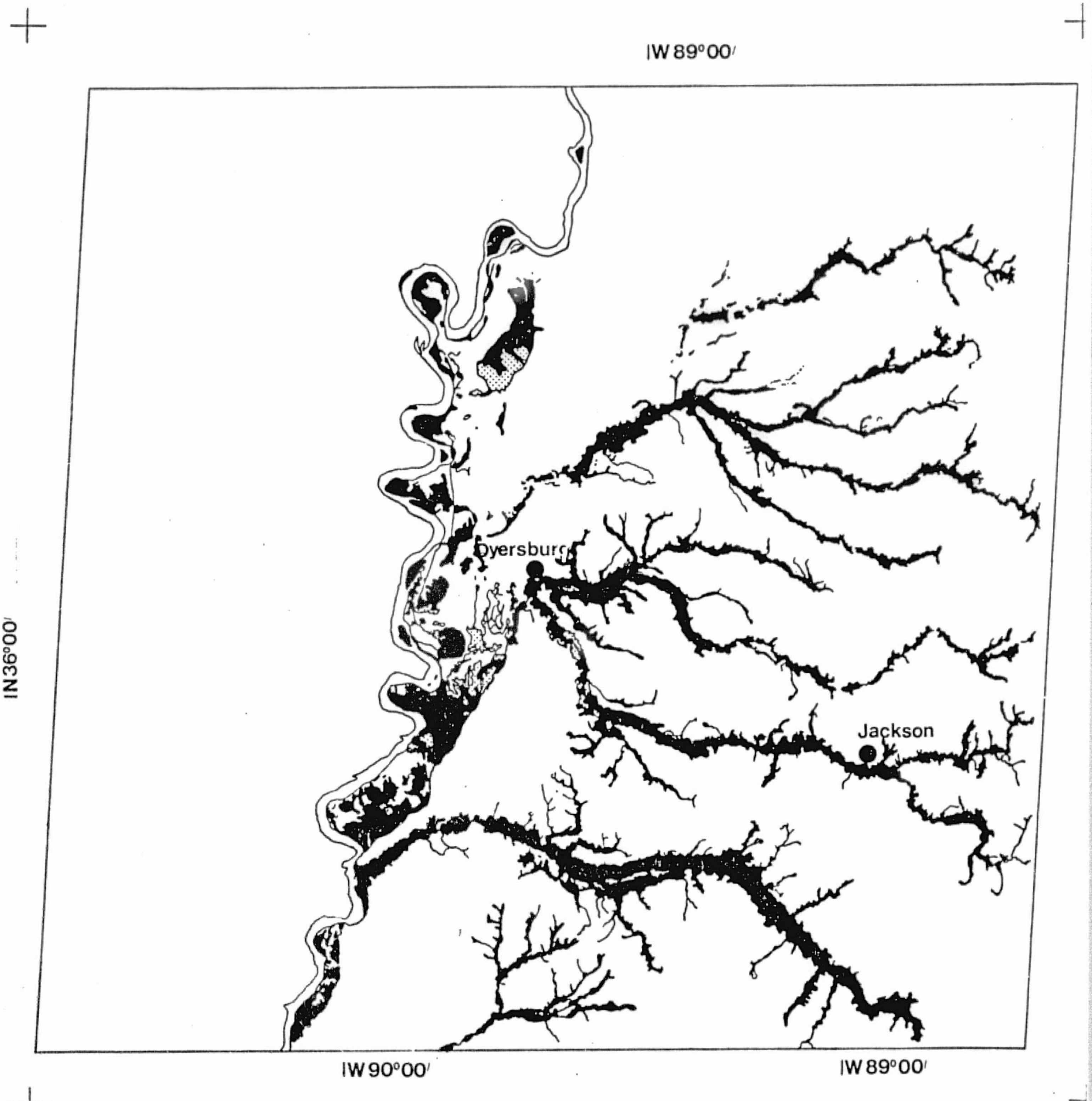
MAP 3. September 13, 1972 - Band 6.



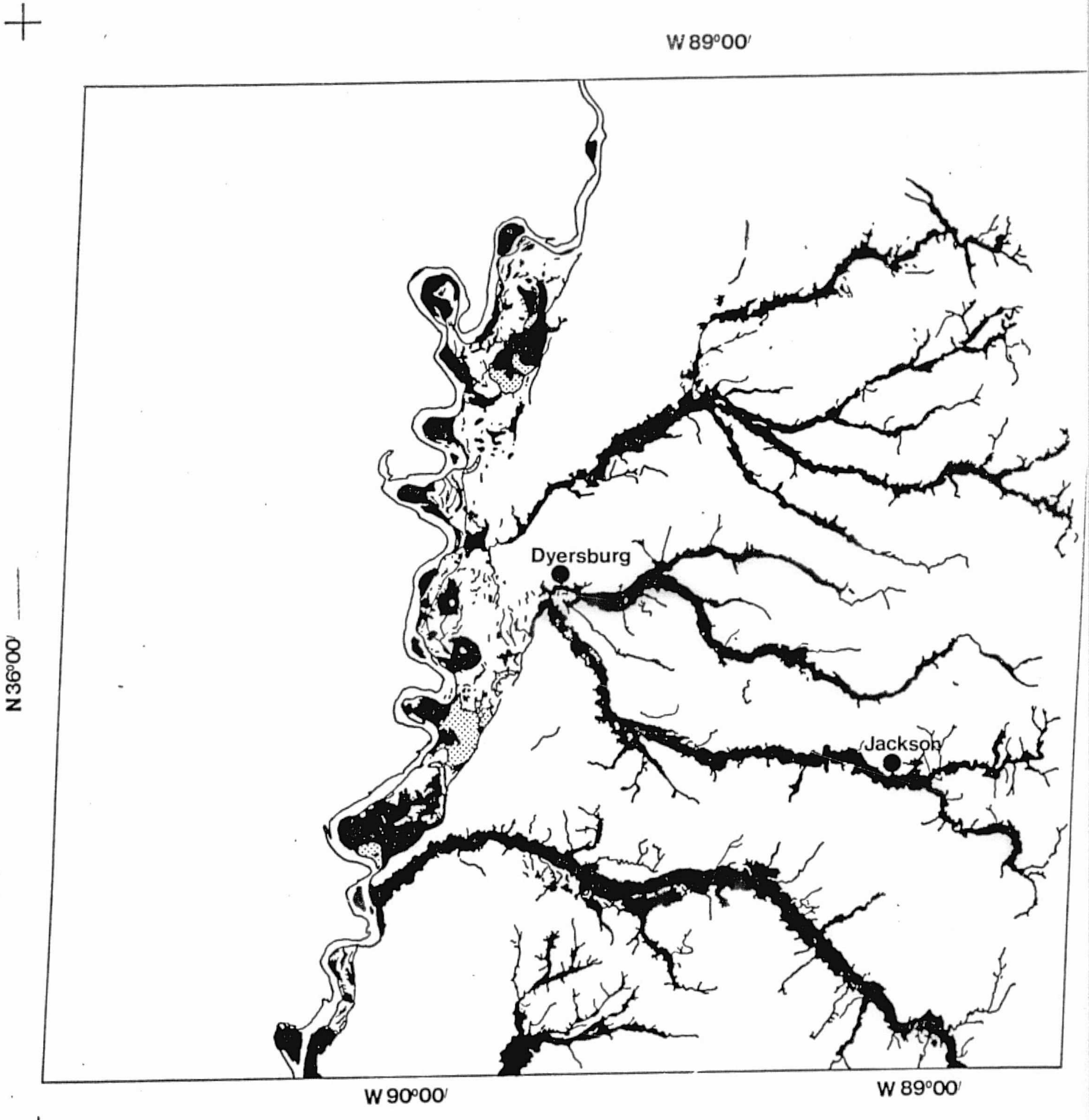
MAP 4. September 13, 1972 - Band 7.



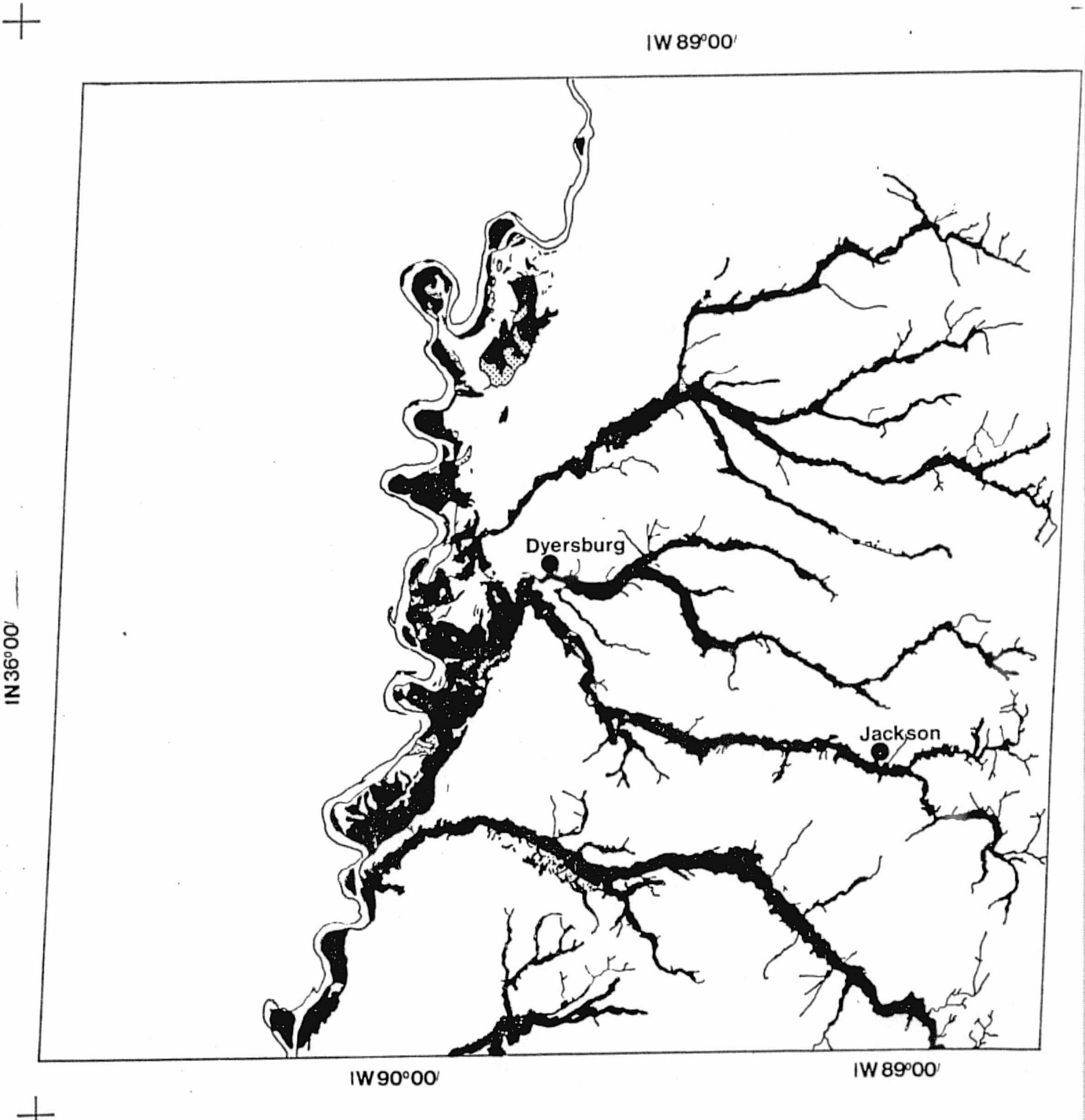
MAP 5. February 22, 1973 - Band 4.



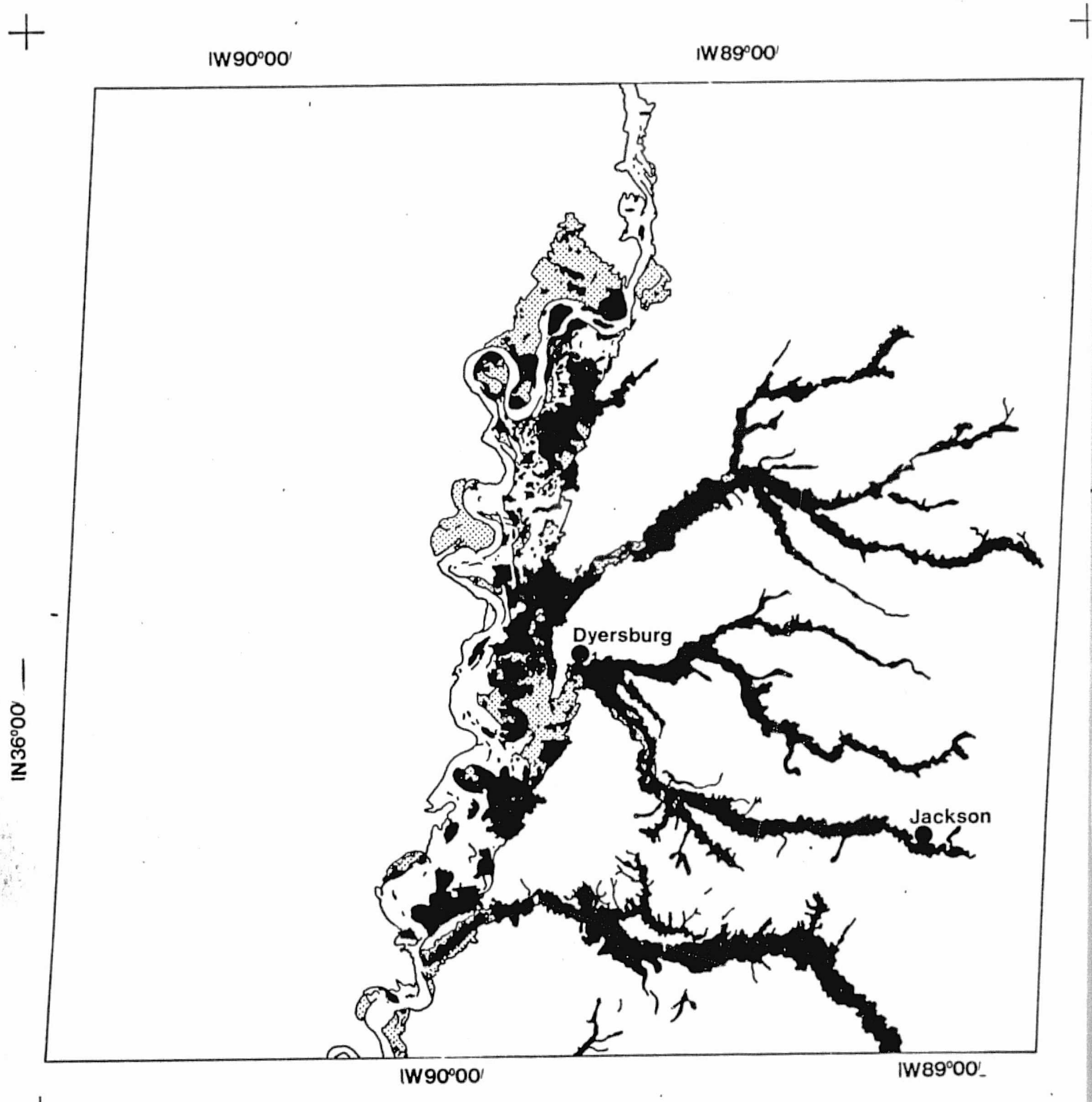
MAP 6. February 22, 1973 - Band 5.



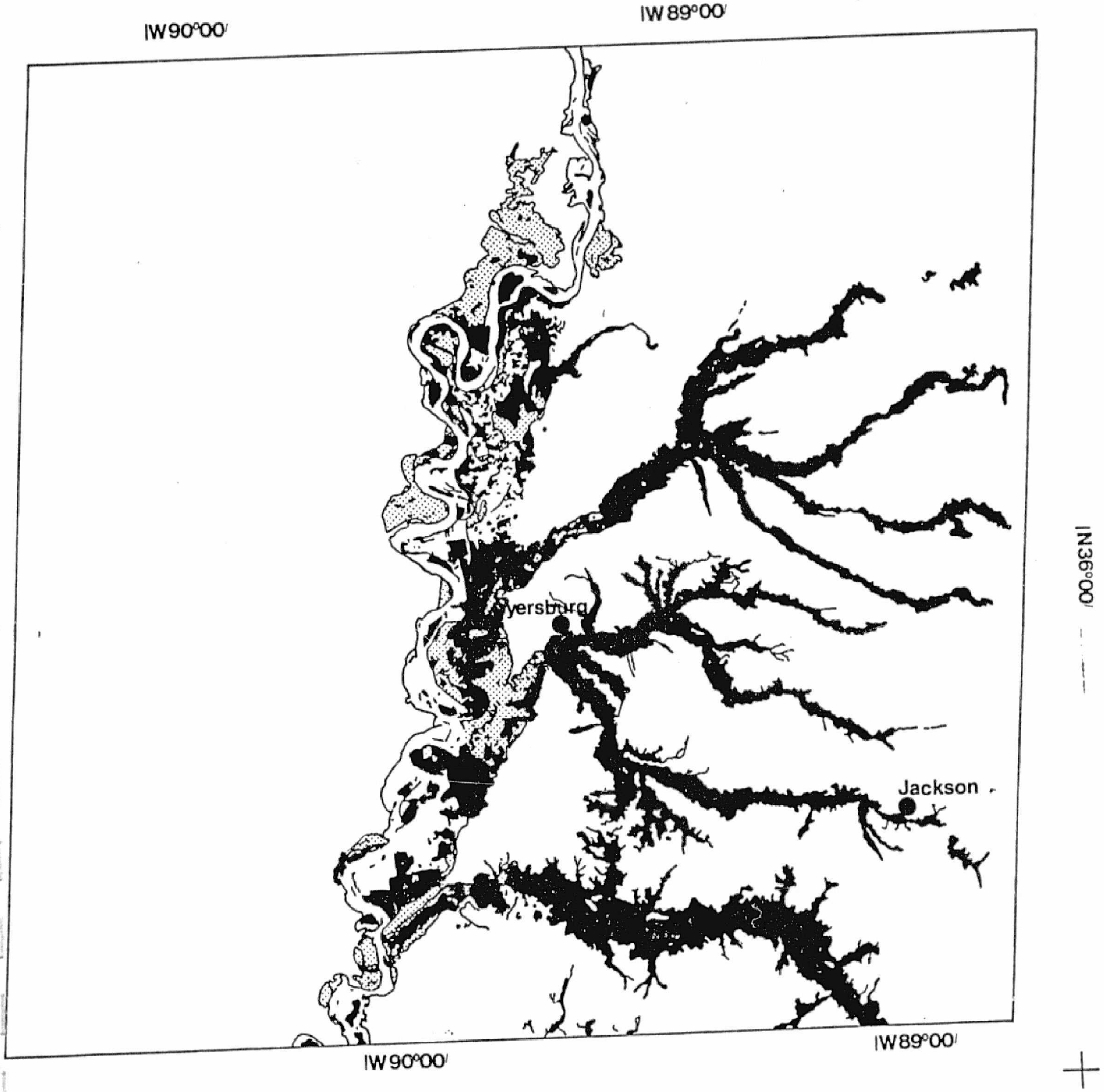
MAP 7. February 22, 1973 - Band 6.



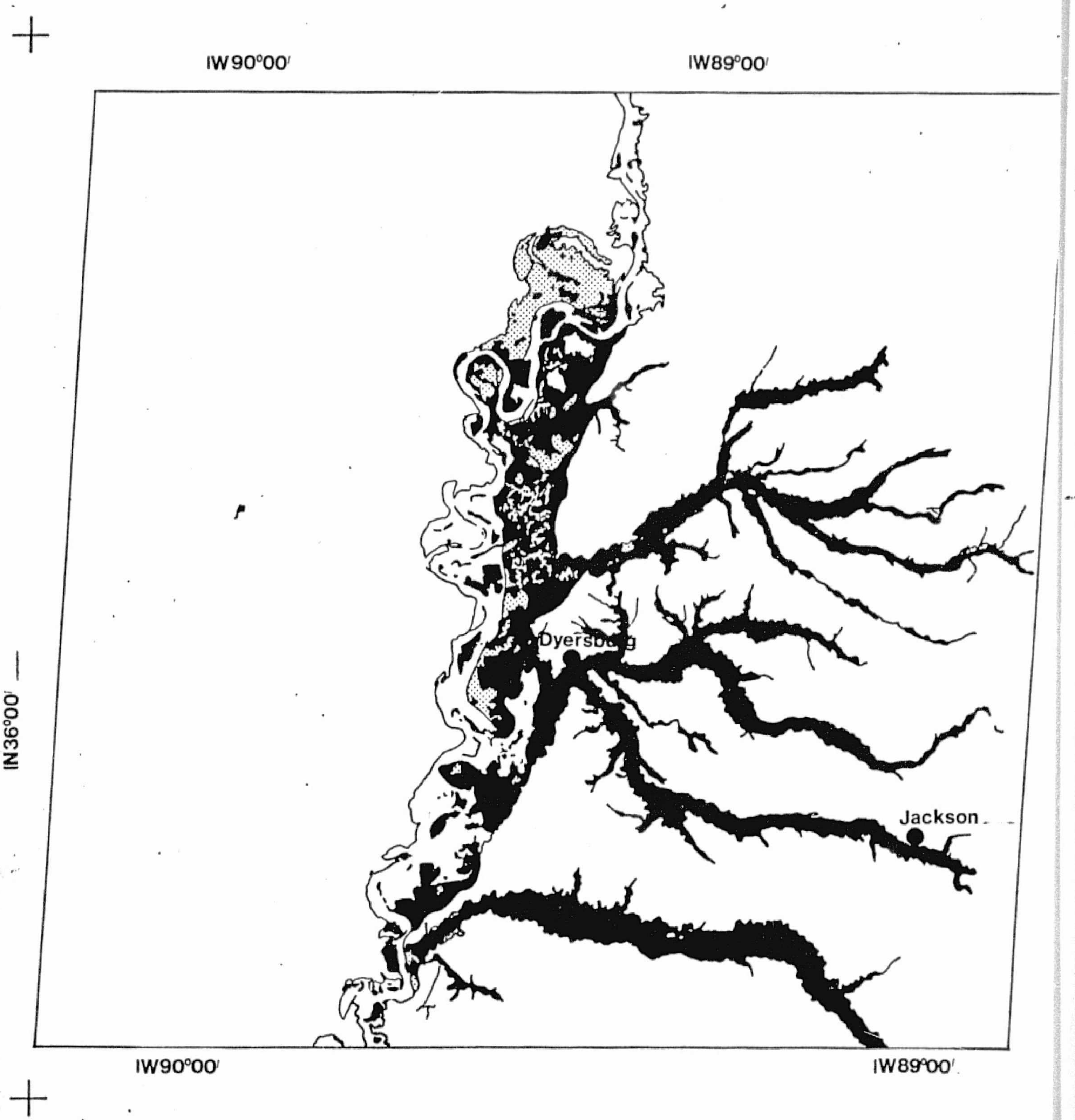
MAP 8. February 22, 1973 - Band 7.



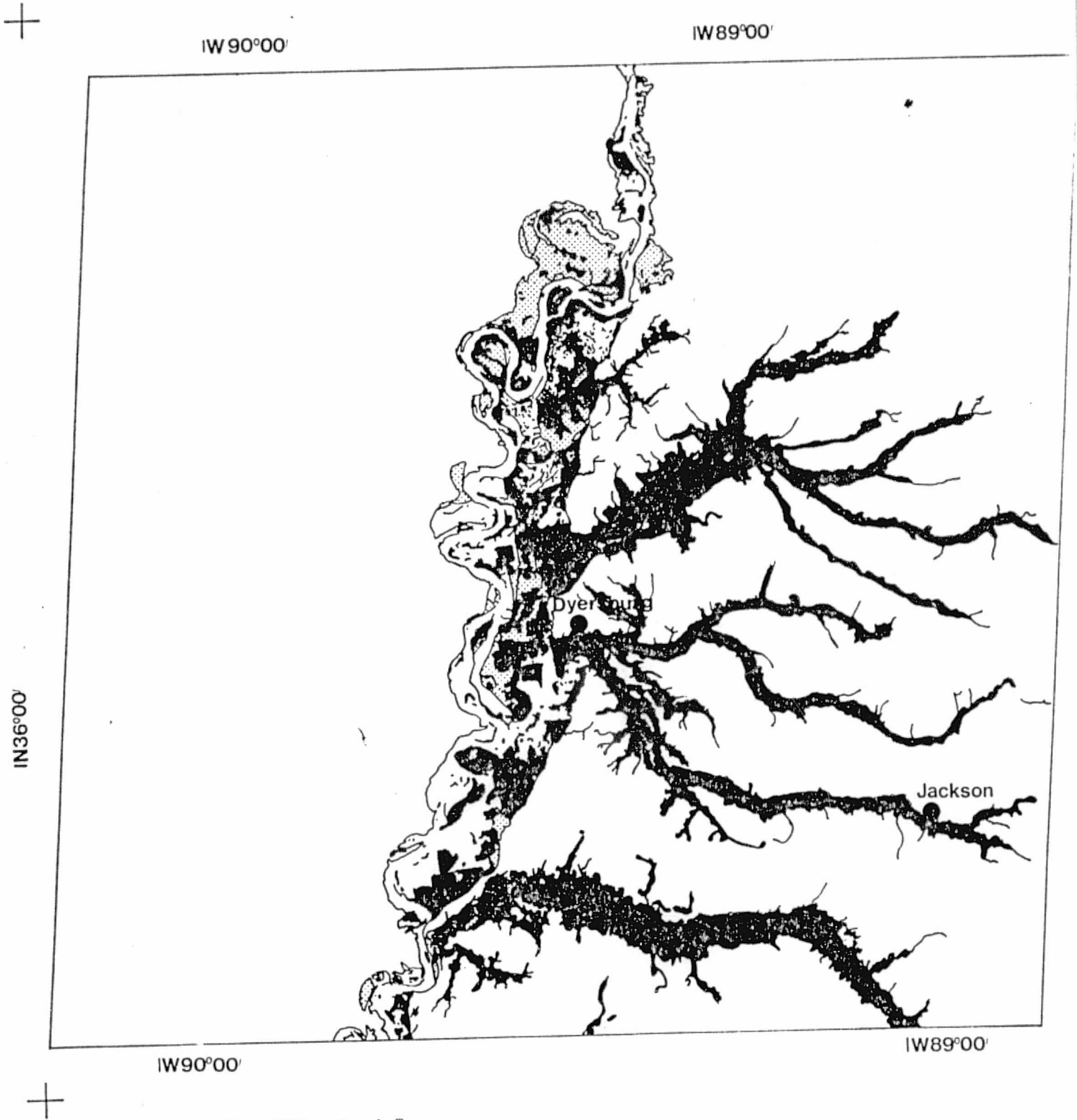
MAP 9. May 5, 1973 - Band 4.



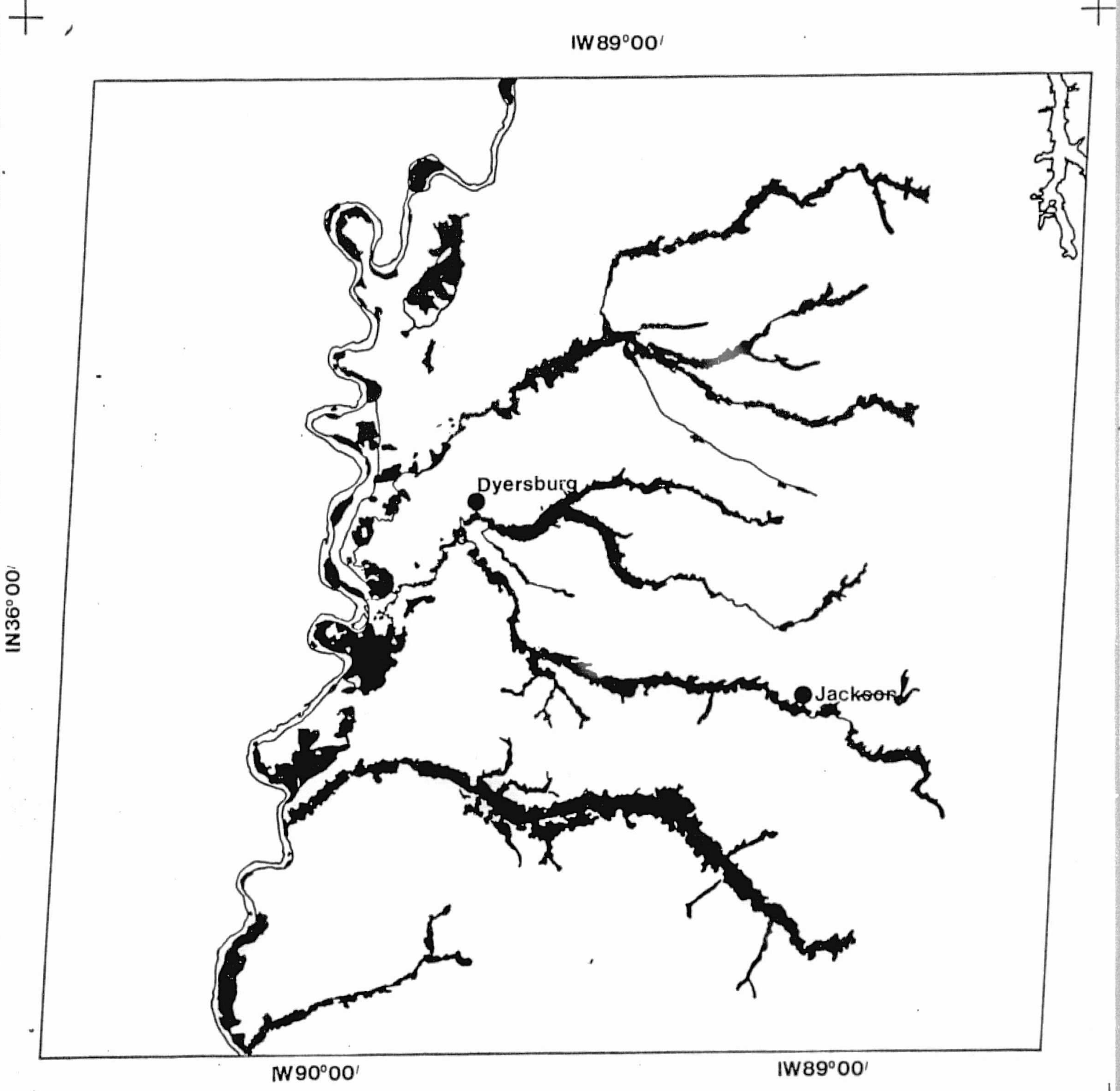
MAP 10. May 5, 1973 - Band 5.



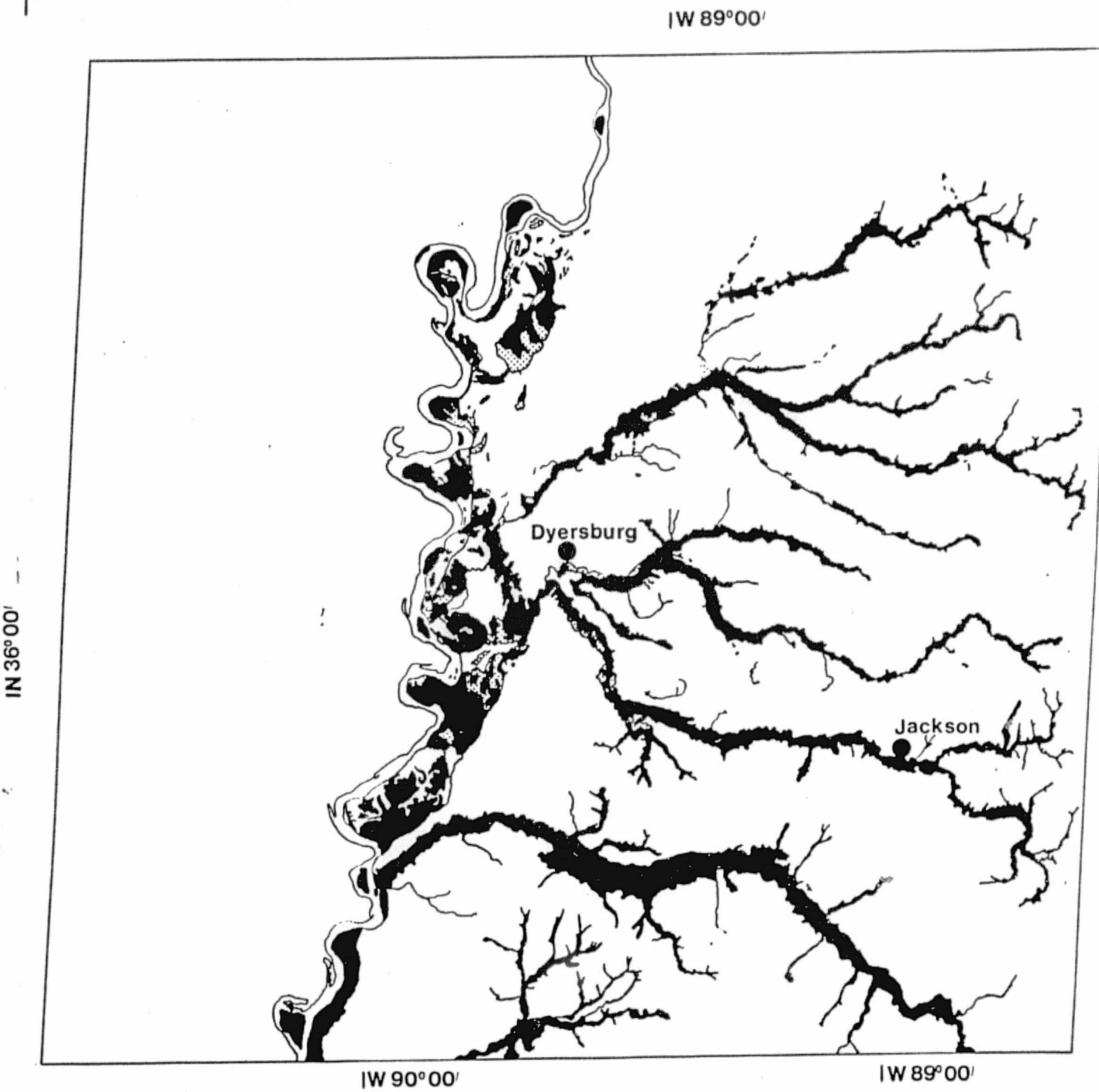
MAP 11. May 5, 1973 - Band 6.



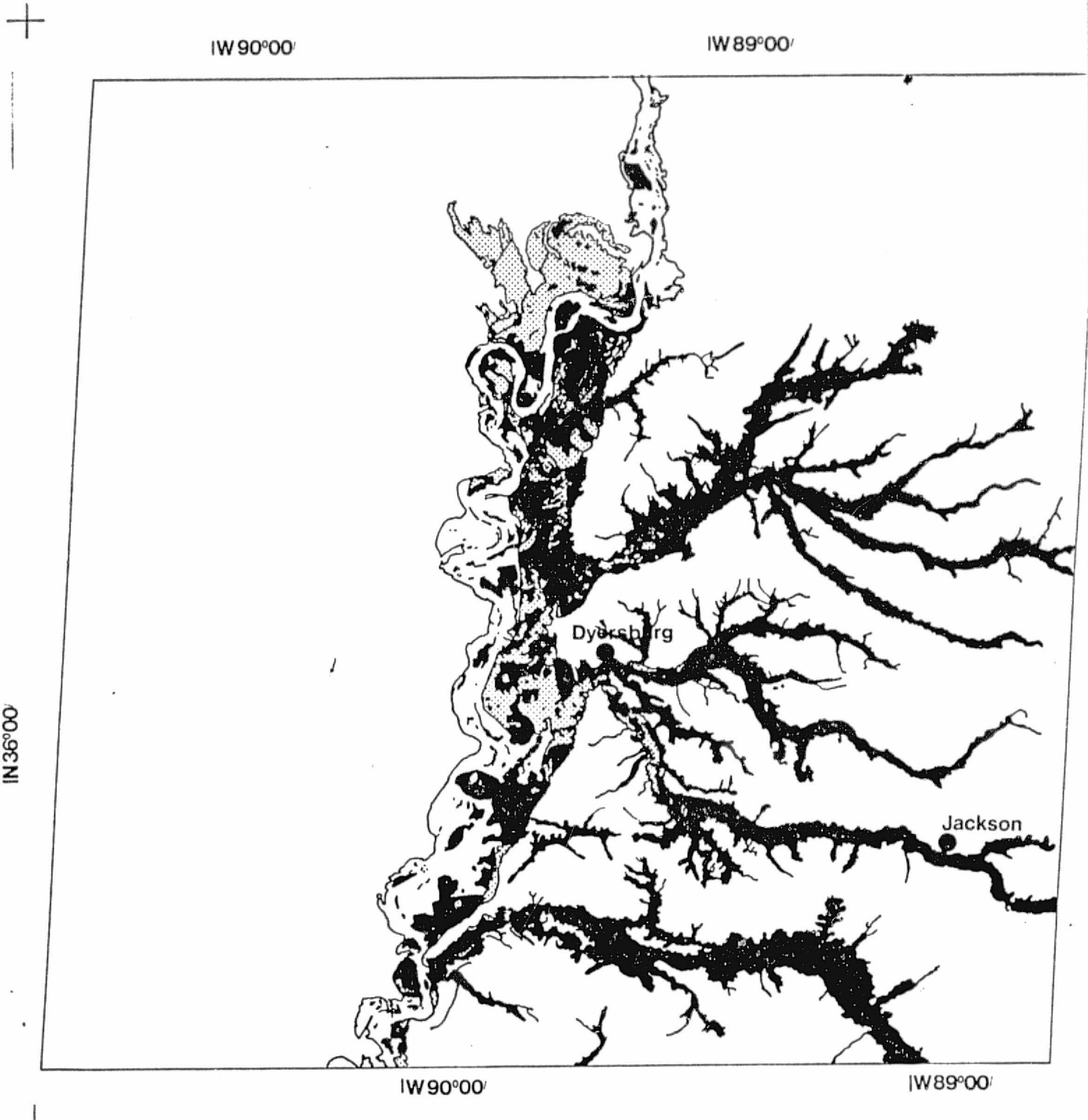
MAP 12. May 5, 1973 - Band 7.



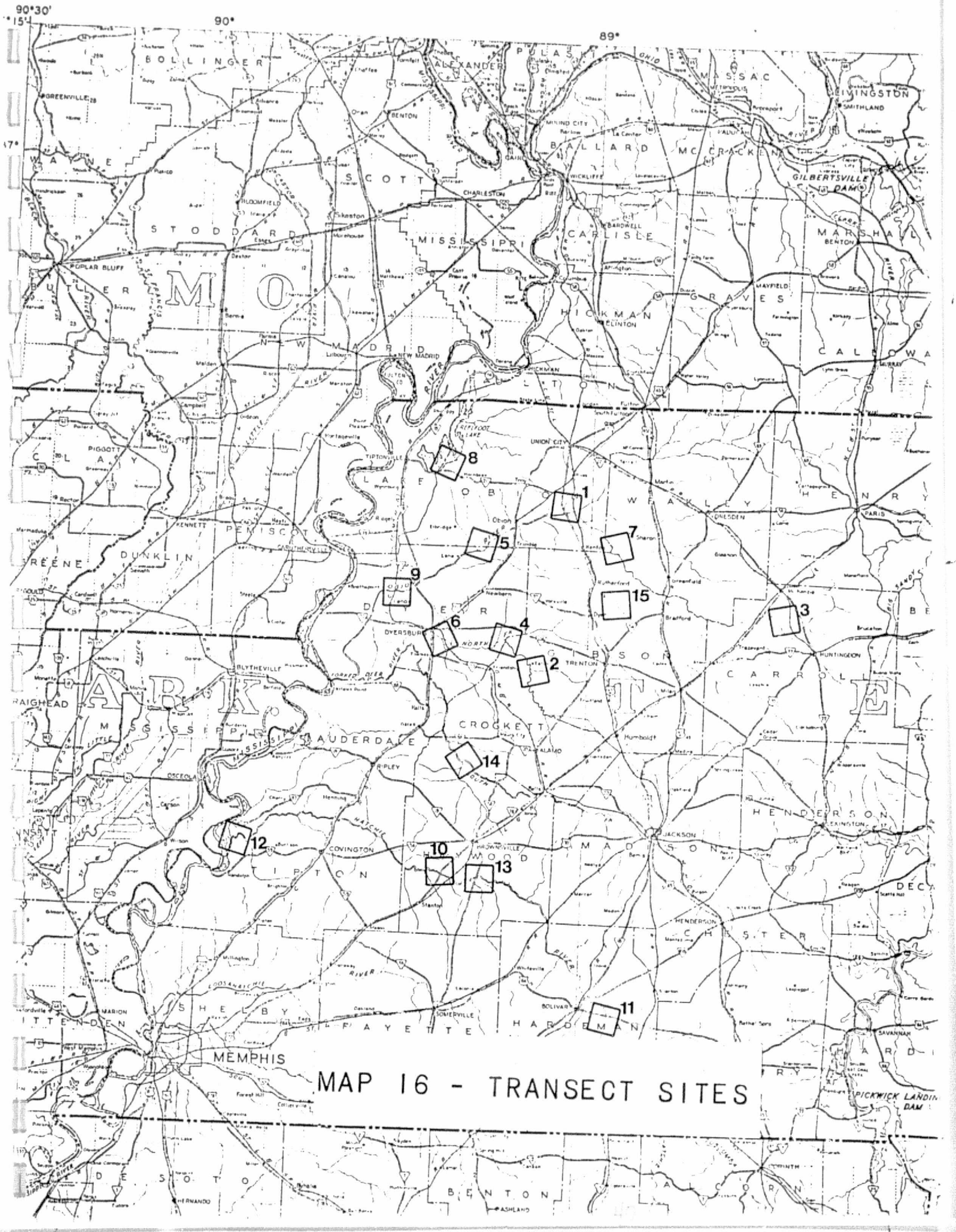
MAP 13. September 13, 1972 - Color Composite MSS.



MAP 14. February 22, 1973 - Color Composite MSS.



MAP 15. May 5, 1973 - Color Composite MSS.



MAP 16 - TRANSECT SITES

LEGEND FOR FIGURE I

Forested Wetland

Marsh

Flooded Land

Saturated Agricultural Land

Rivers and Streams

Roads

Railroads

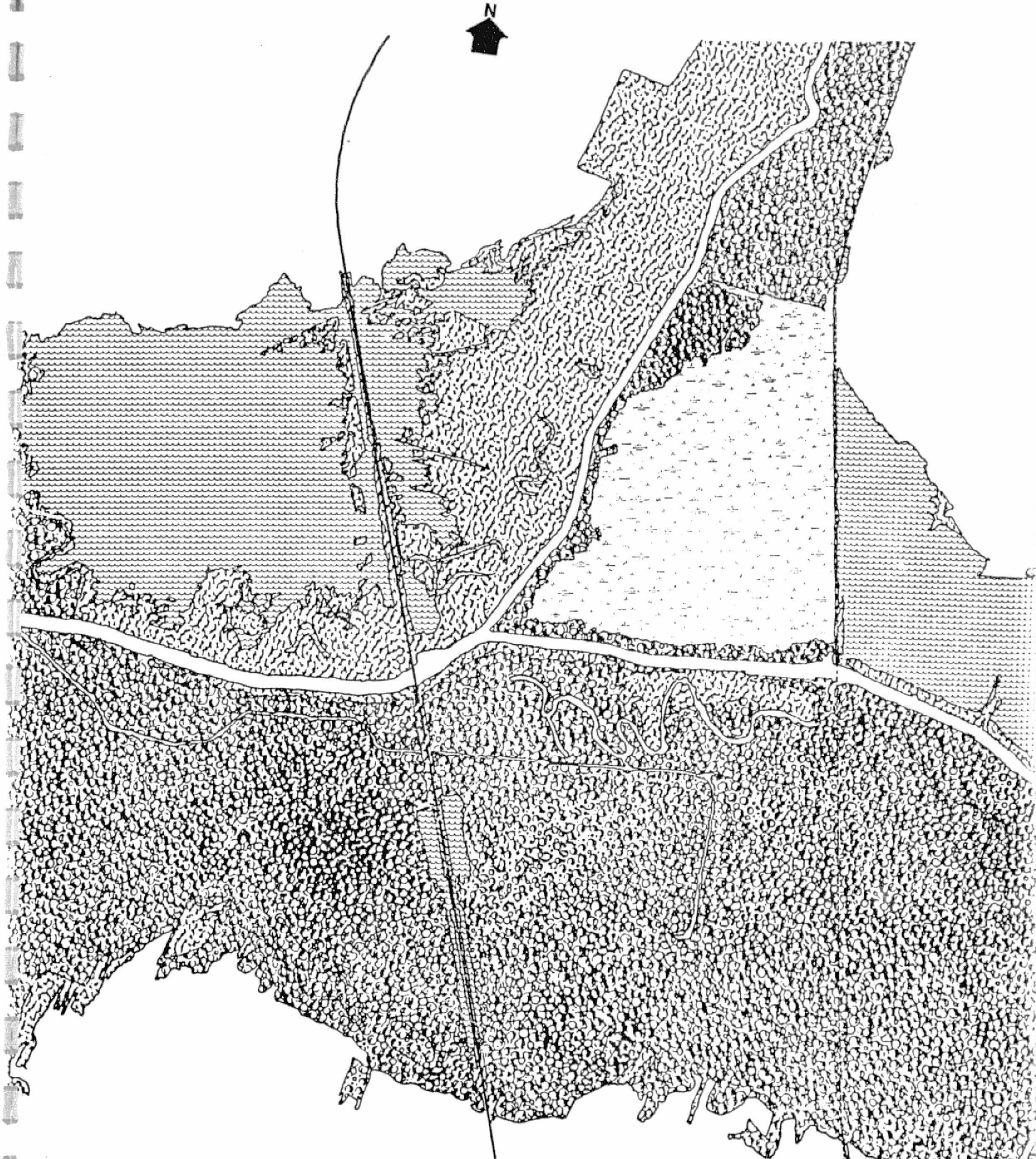


FIGURE 1. Confluence of the North and South Forks of the Obion River.

LEGEND FOR FIGURES 2-4

Forested Wetland

Non-Forested Wetland

Dead Timber

Flooded Land

Saturated Agricultural Land

Lakes

Rivers and Streams

Roads

Railroads

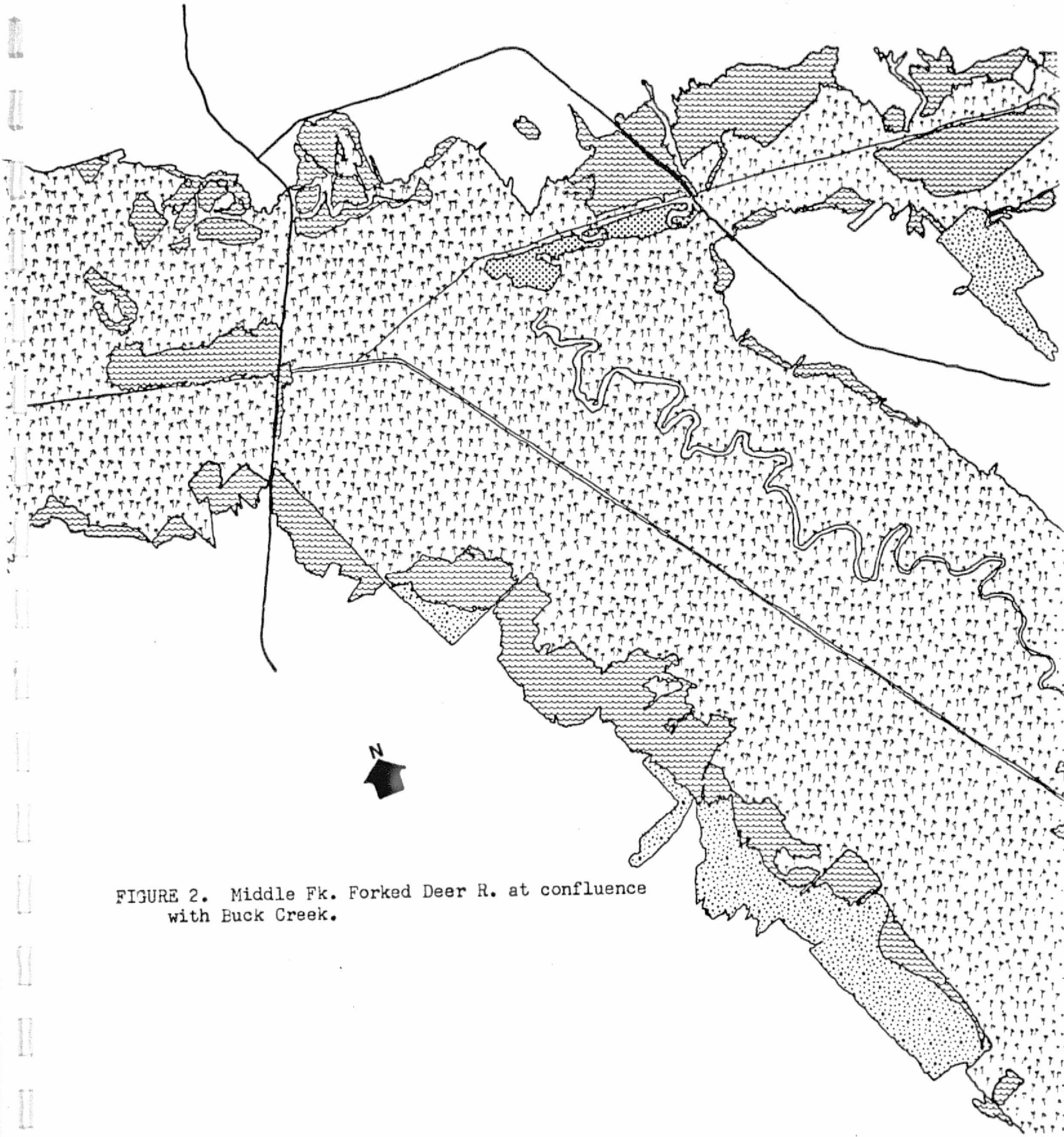


FIGURE 2. Middle Fk. Forked Deer R. at confluence with Buck Creek.

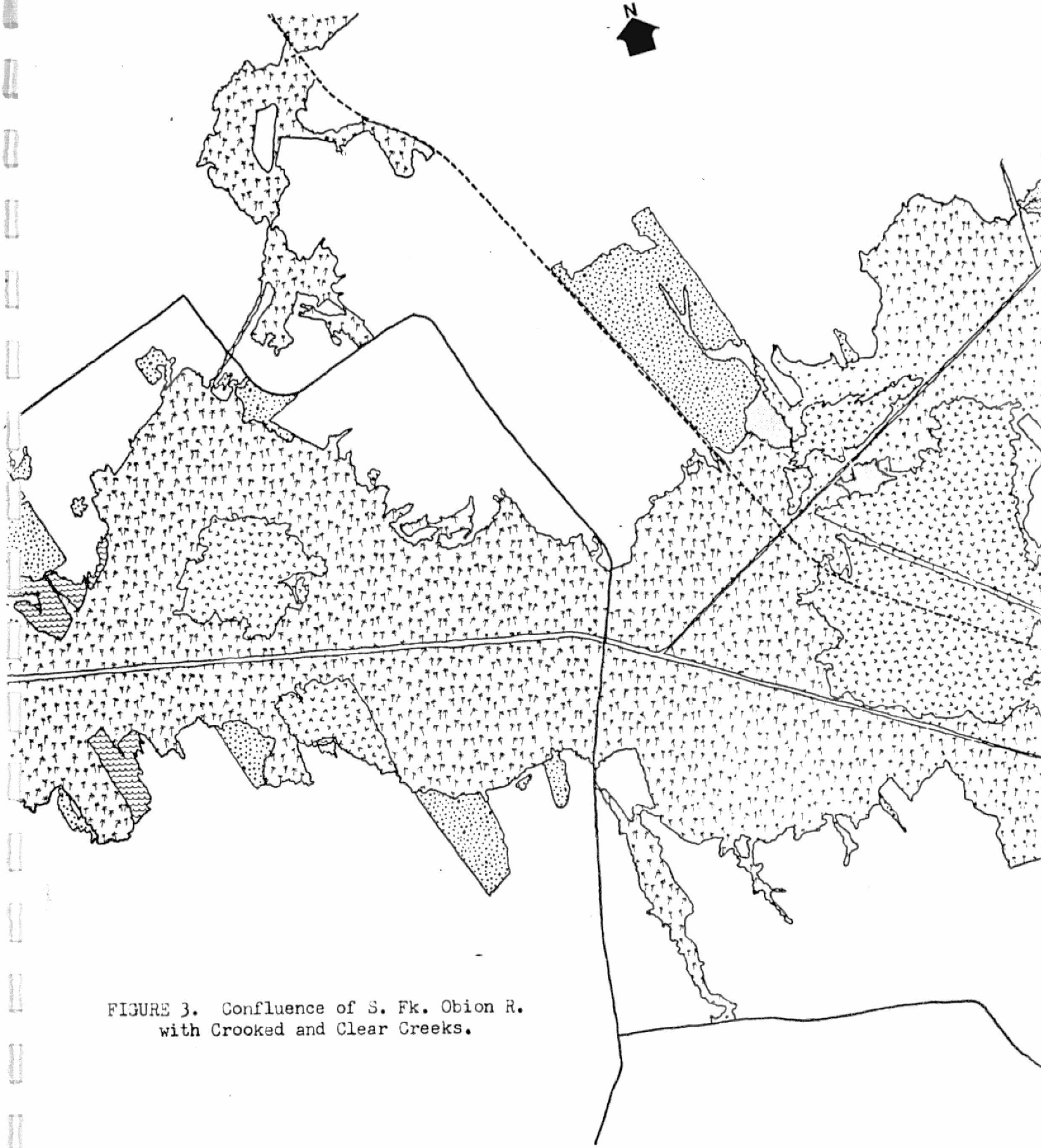


FIGURE 3. Confluence of S. Fk. Obion R. with Crooked and Clear Creeks.

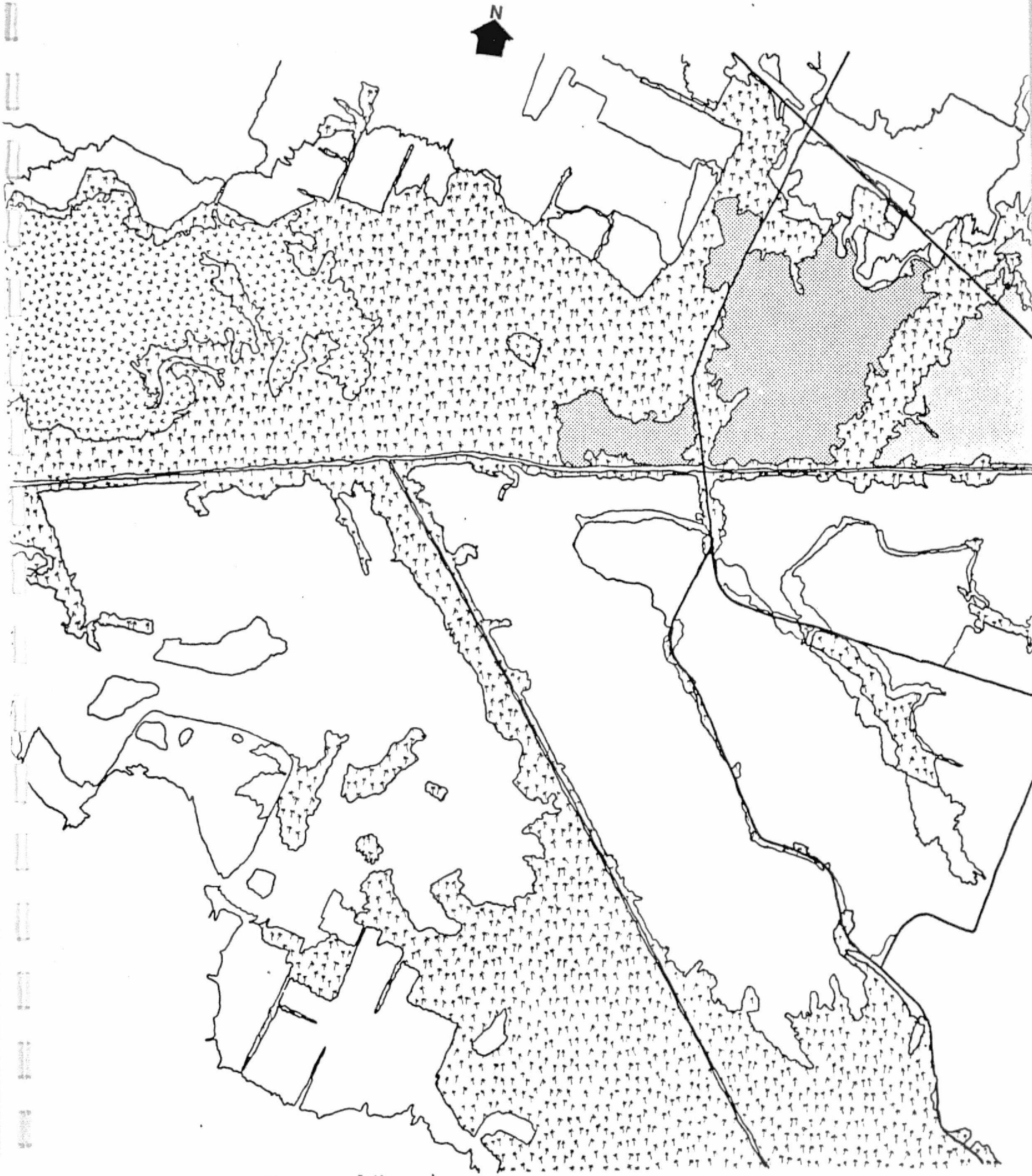


FIGURE 4. Confluence of N. and
Middle Fks. of the Forked Deer River.

LEGEND FOR FIGURES 5-15

- Forested Wetland
- Non-Forested Wetland
- Marsh
- Dead Timber
- Flooded Land
- Saturated Agricultural Land
- Urban or Built-up Land
- Lakes
- Rivers and Streams
- Roads
- Railroads

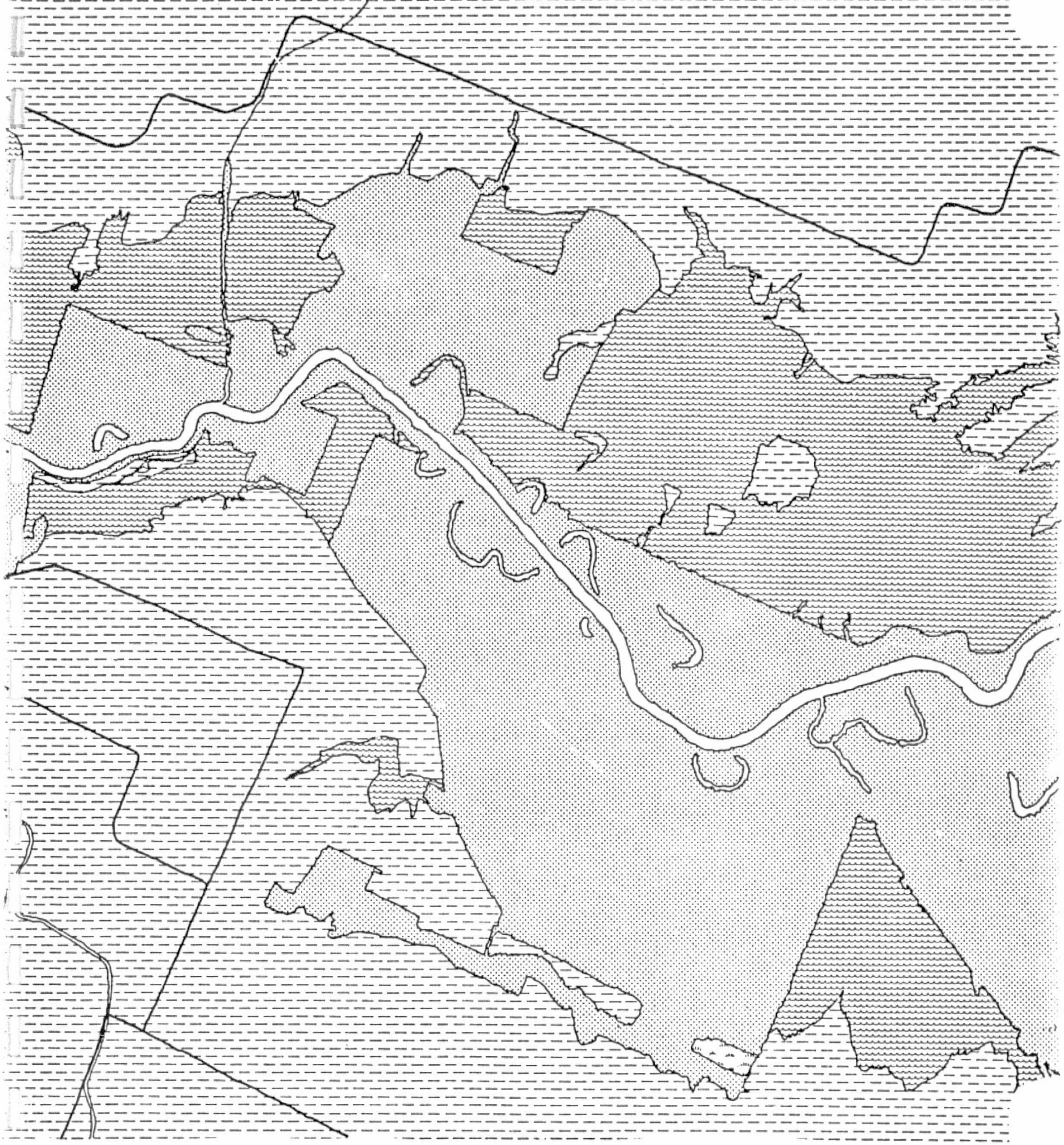


FIGURE 5. Lower Obion R. southwest of Obion, Tennessee.

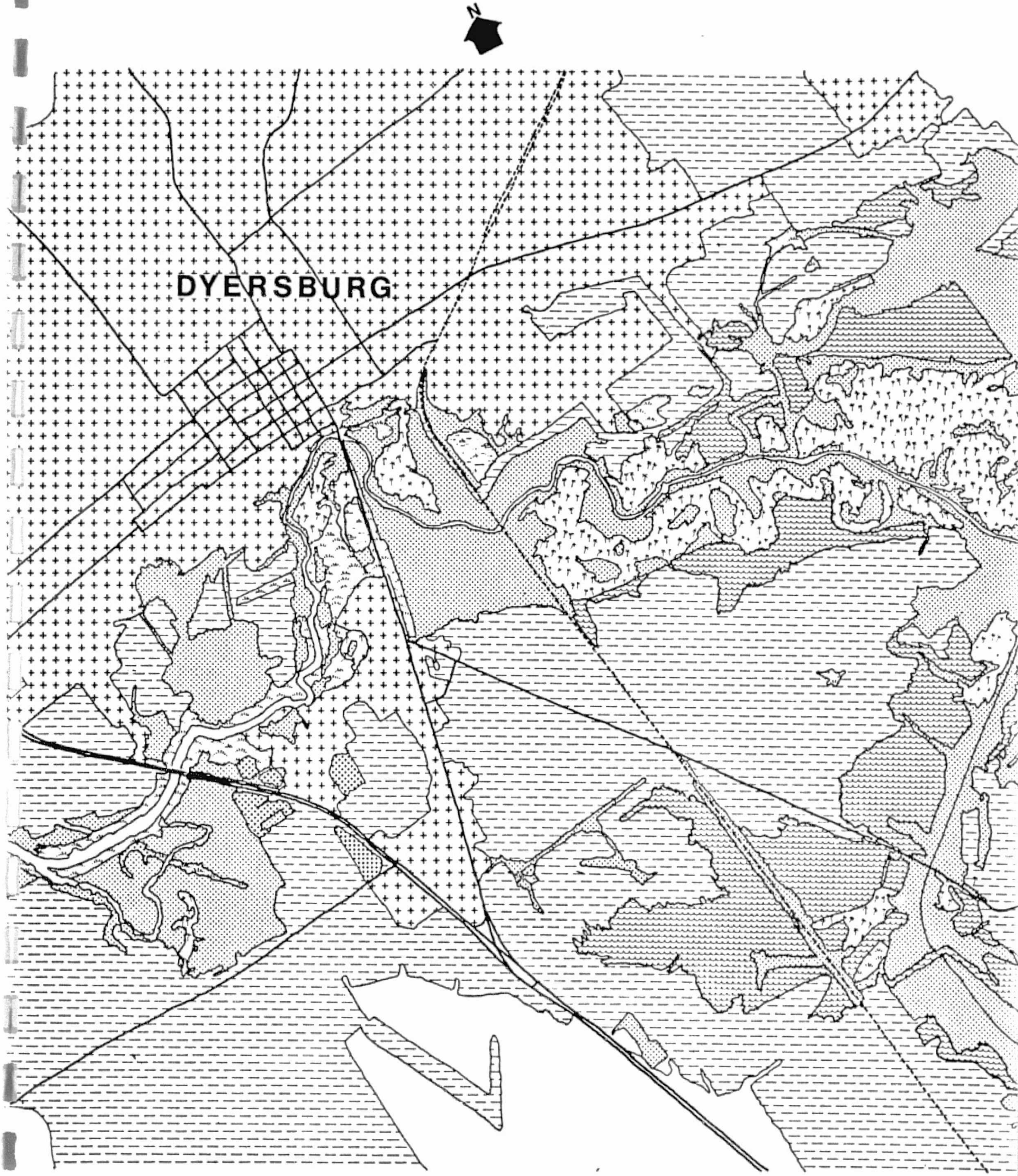


FIGURE 6. Forked Deer R. at Dyersburg, Tennessee.

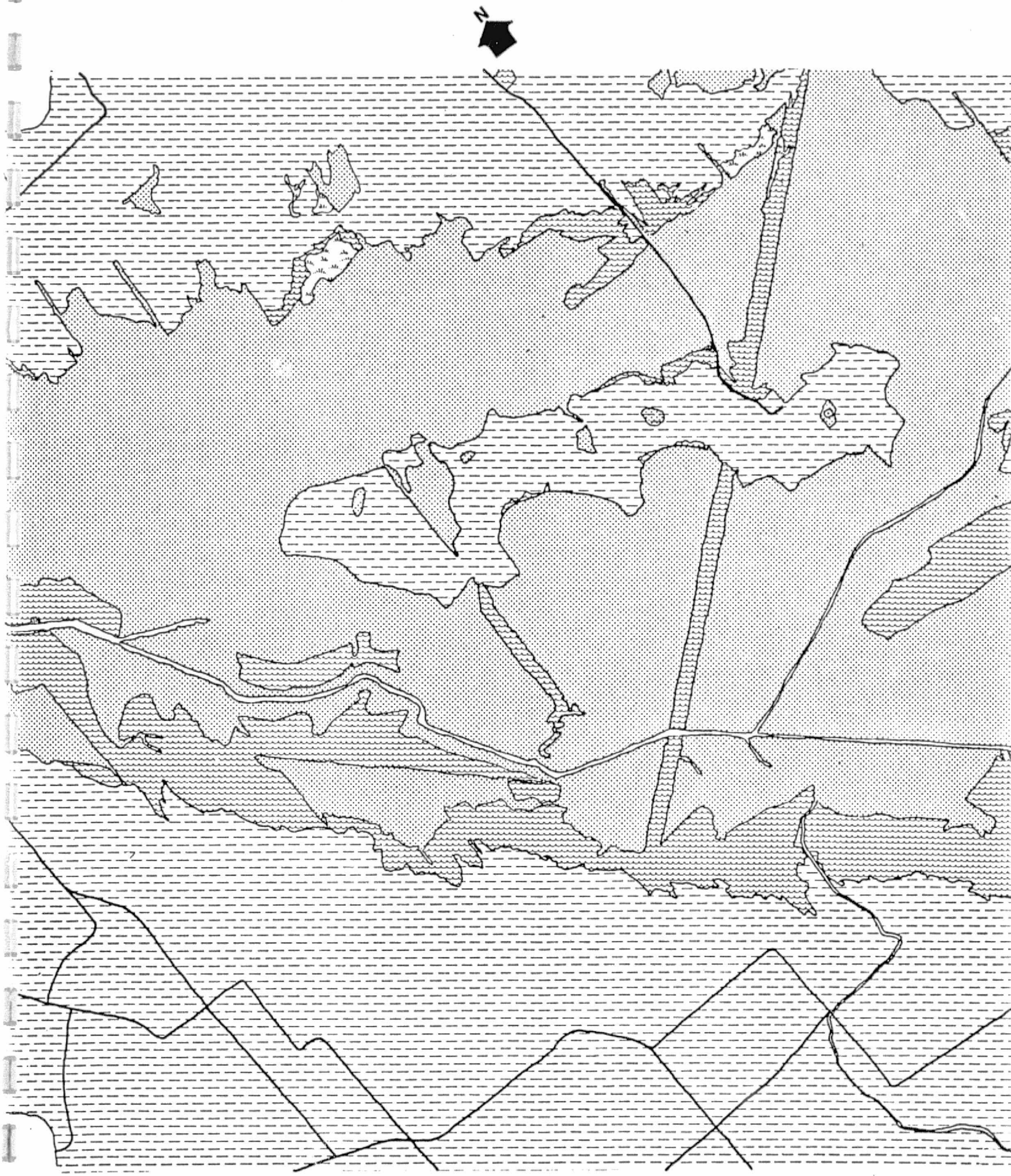


FIGURE 7. Confluence of the Middle and S. Fks. of the Obion River.

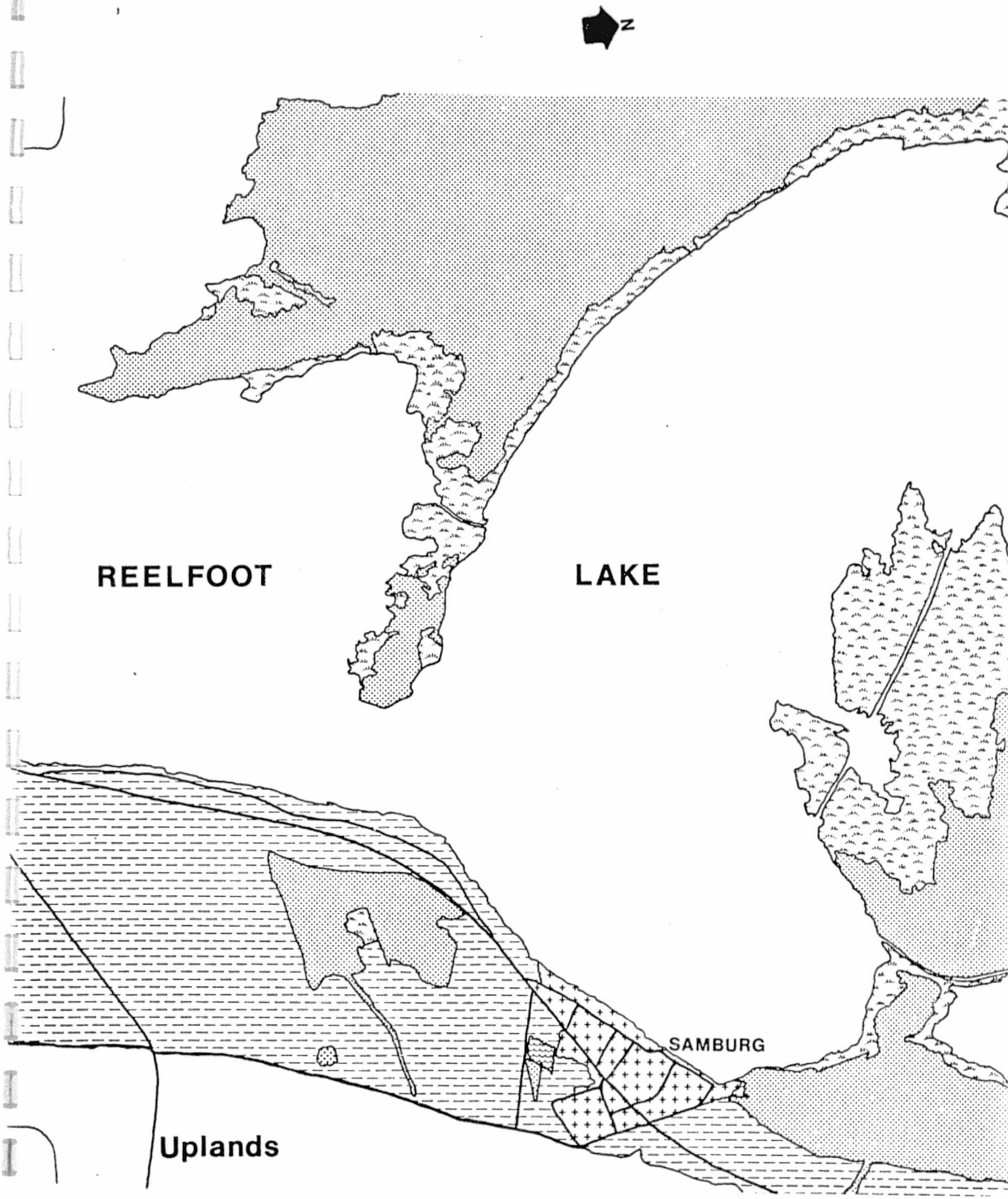


FIGURE 8. Reelfoot Lake at Samburg, Tennessee.

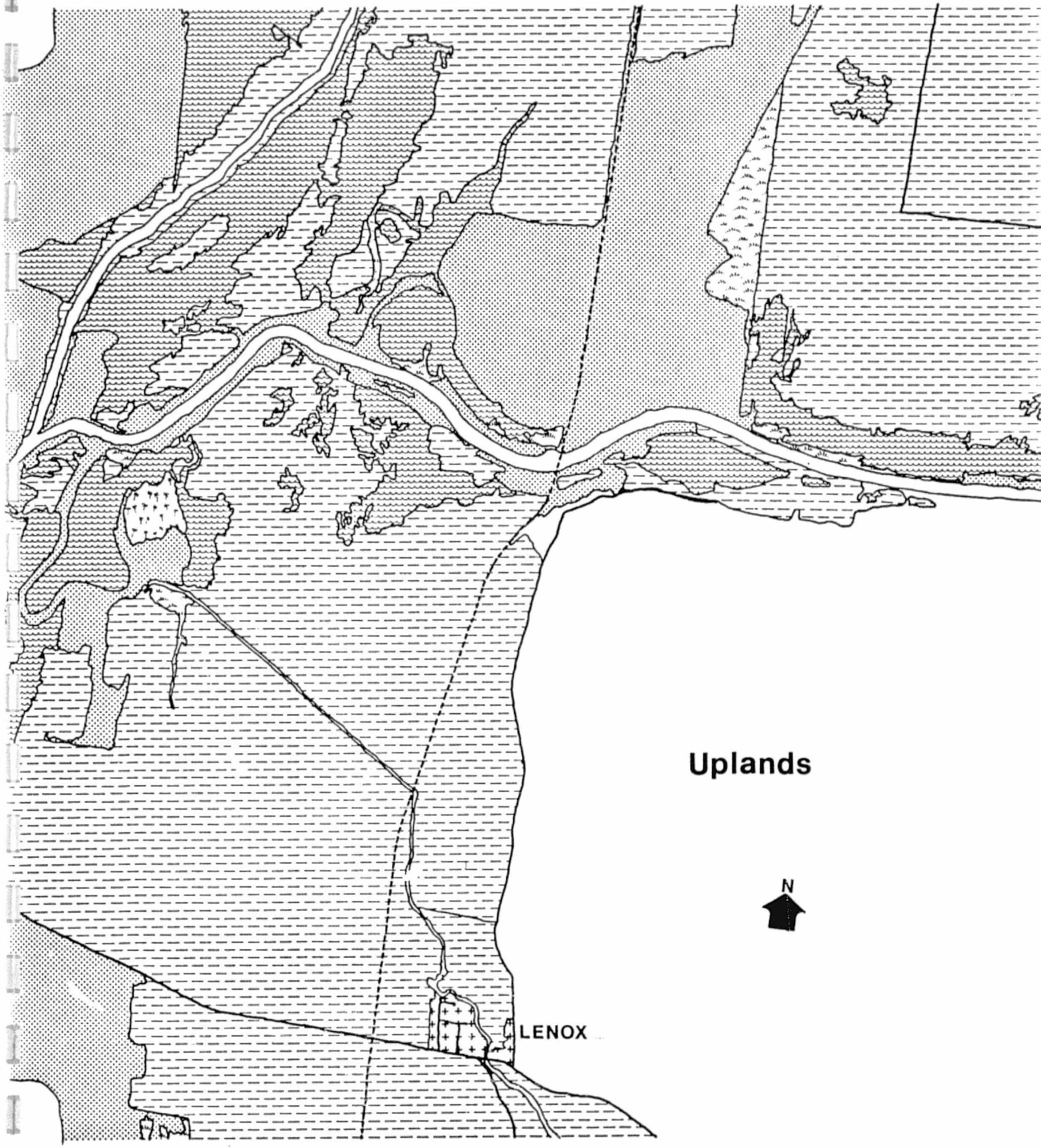


FIGURE 9. Obion R. at confluence with Running Reelfoot Bayou.

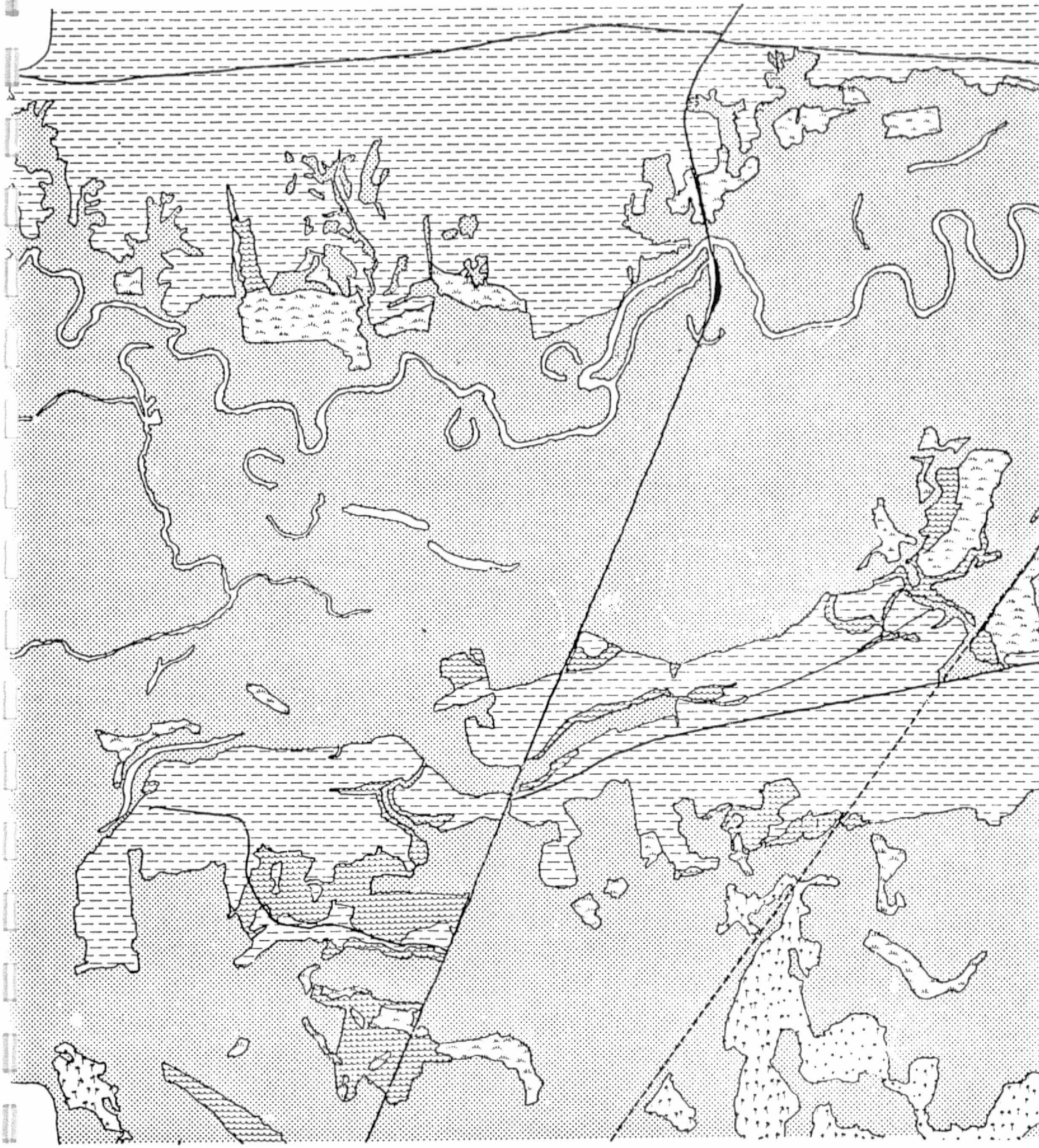


FIGURE 10. Hatchie R. at crossing of U.S. Route 79.

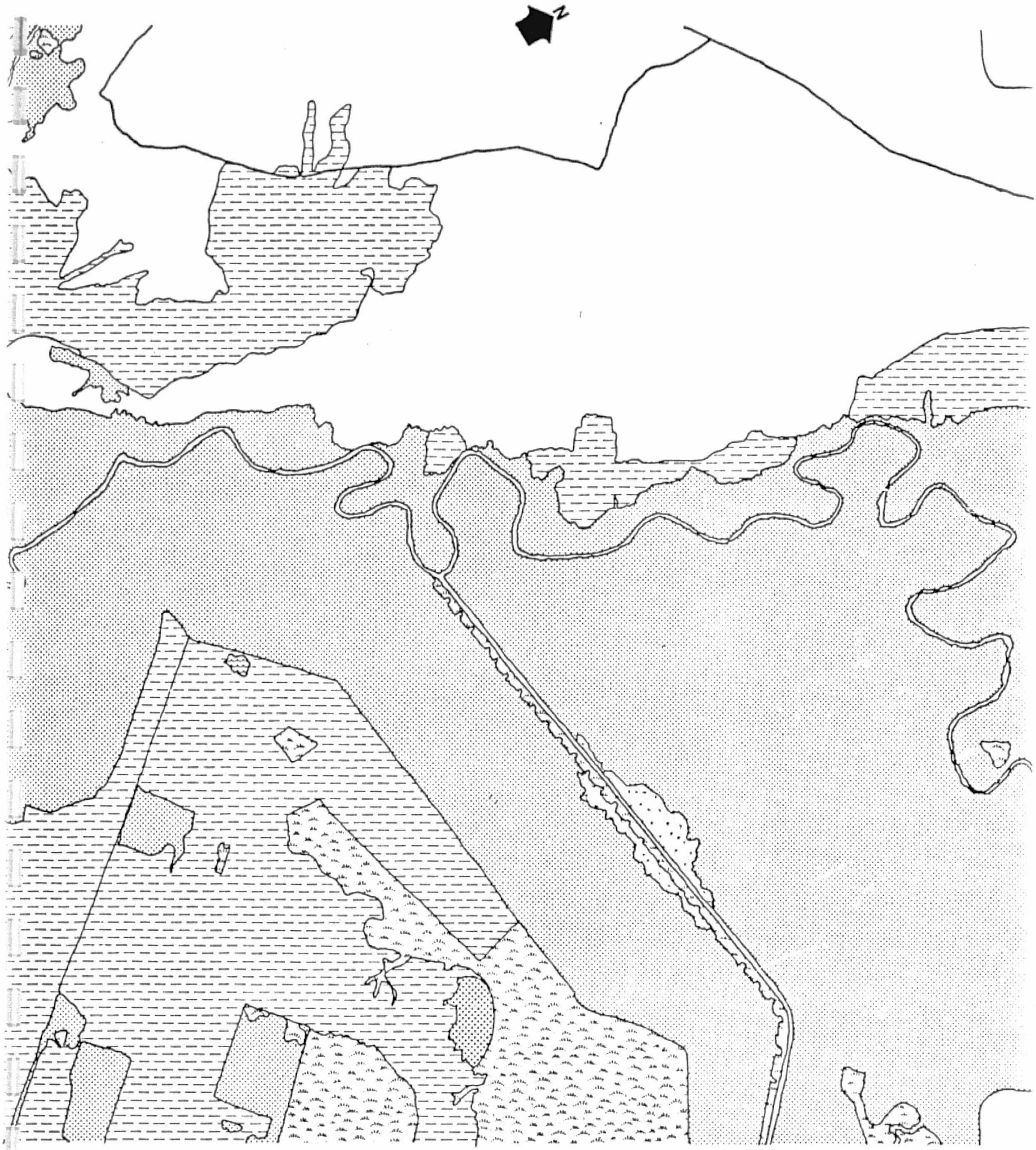


FIGURE 11. Hatchie R. at confluence with Big Bottom Drainage Canal.

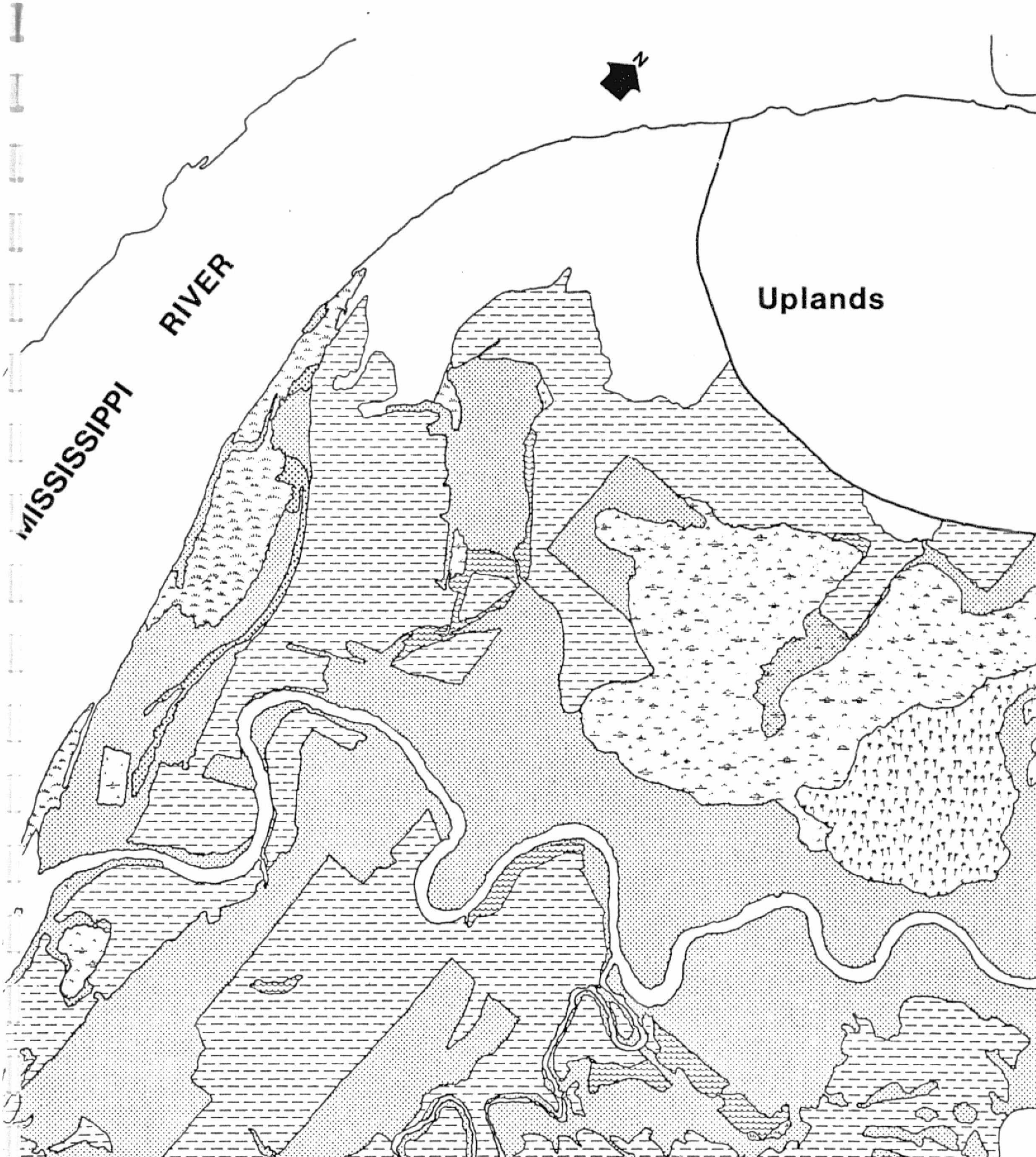


FIGURE 12. Hatchie R. at confluence with the Mississippi R.

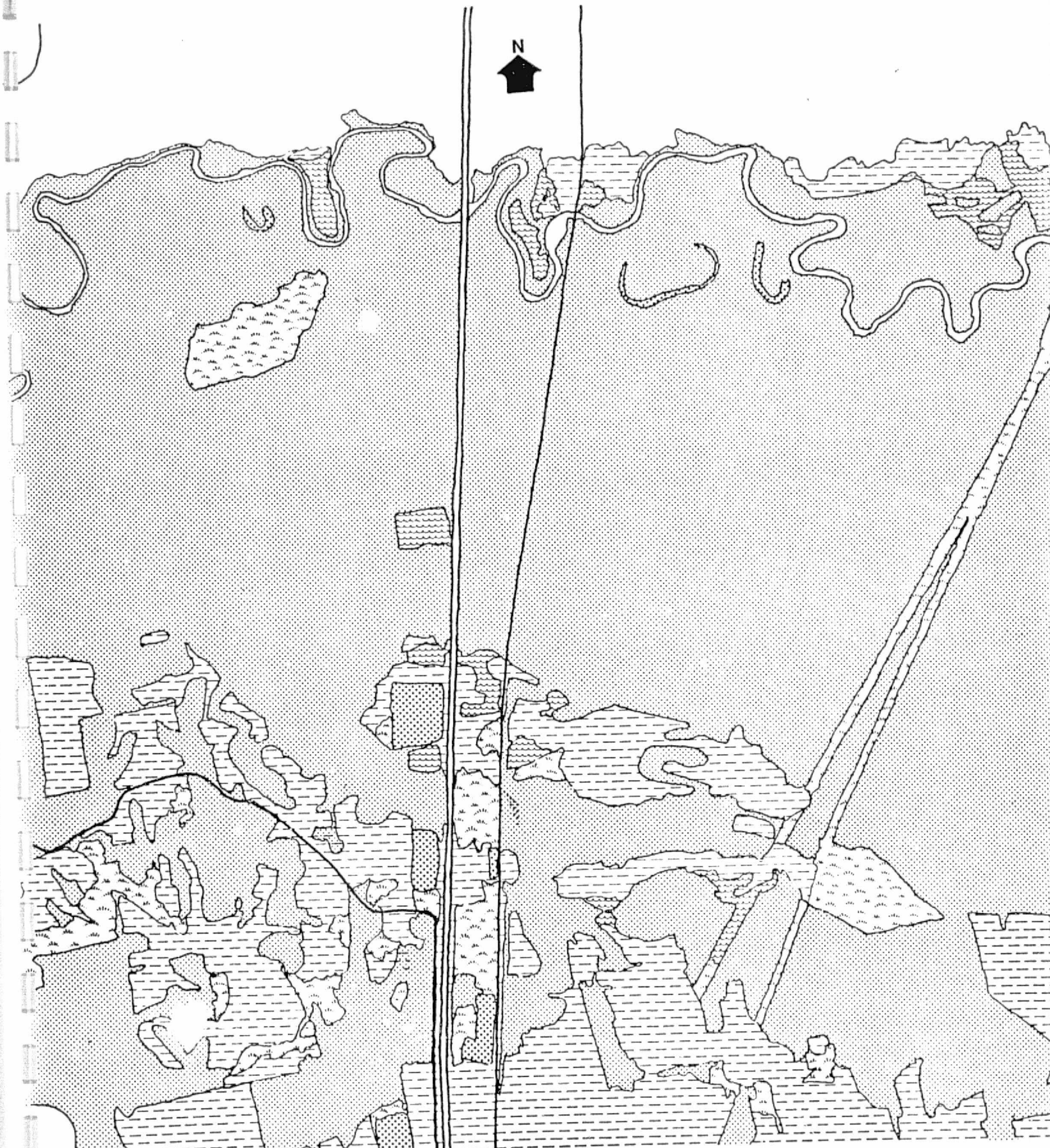


FIGURE 13. Hatchie R. at crossing of I-40 and S.R. 76.

FIGURE 14. Confluence of S. Fk. Forked Deer R. with Nixon Creek.

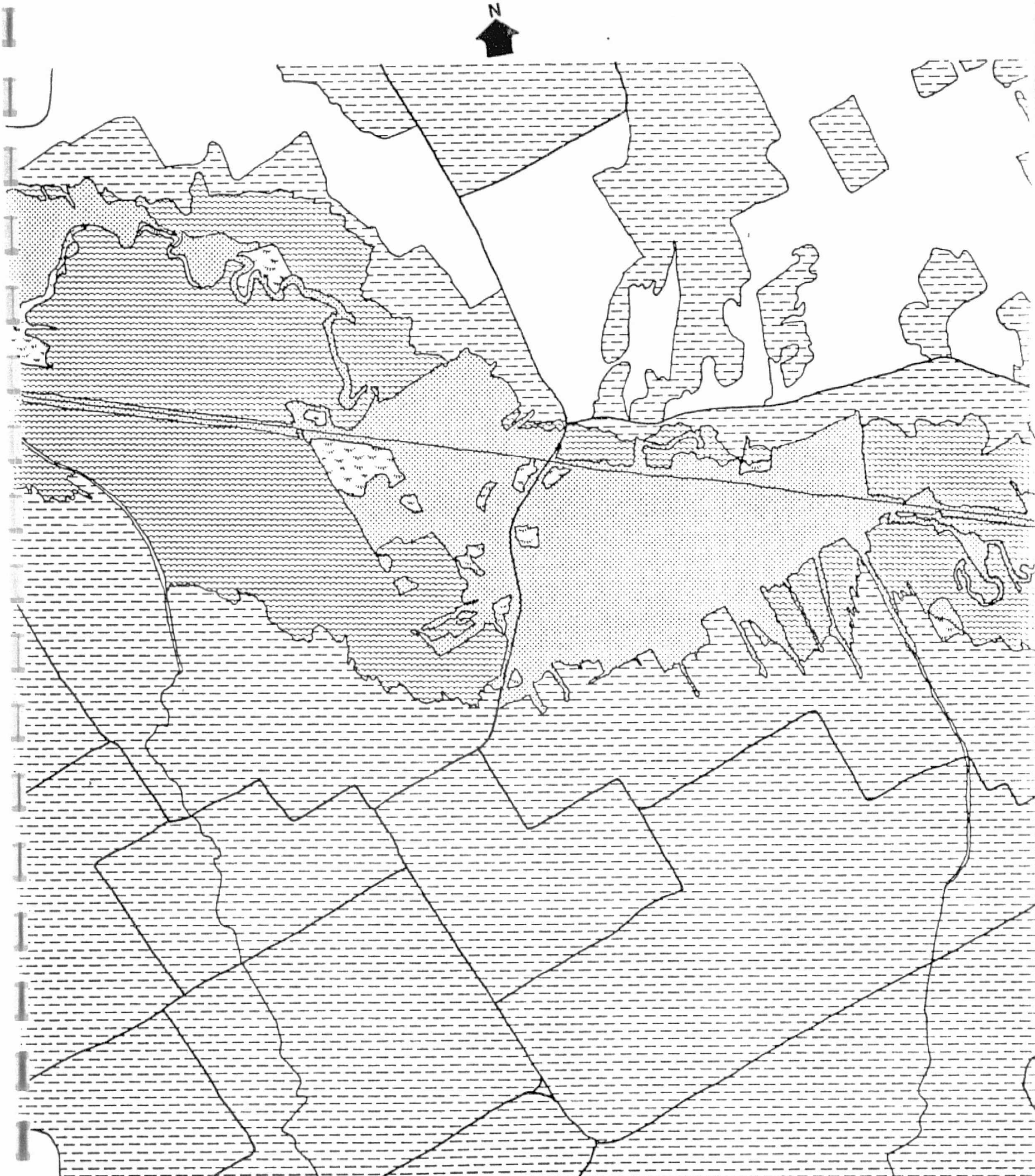


FIGURE 15. Rutherford Fk. Obion R. east of Dyer, Tennessee.